

# **3720 ACM**

**Advanced Digital Power  
Instrumentation Package**

## **Installation & Operation Manual**

**CONTENTS**

## Danger

During normal operation of this device, hazardous voltages are present which can cause severe injury or death. These voltages are present on the terminal strips of the device and throughout the connected potential transformer (PT), current transformer (CT), status input, relay, and control power circuits. Installation and servicing should be performed only by qualified, properly trained personnel. See Chapter 2: Installation for additional warnings.

## Warning

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instructions manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area may cause interference in which case the operator will be required to take whatever measures may be required to correct the interference.

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## CONVENTIONS

Throughout this operation manual, the following methods are used to highlight important information:

### NOTE

Describes important considerations related to a device setup, feature or application.

### CAUTION

Alerts you to a condition which could potentially cause damage to the device or other external equipment.

### WARNING or DANGER

Warns you to avoid conditions that could potentially cause serious personal injury and/or equipment damage.

## SYMBOLS

Wiring diagrams and labels use symbols to denote the following objects:



Fuse



Potential Transformer (PT)



Current Transformer (CT)



Switchgear chassis (Earth) ground



Alternating current



Direct current



Three-phase alternating current



Protective conductor terminal

## DISPLAY TIMEOUT

This device has a *display timeout* feature which automatically turns off the front panel display after a programmable timeout period. When the device is shipped, this timeout period is preset to 180 minutes (3 hours). Following a display timeout, you can turn the display back on by pressing any button on the front panel.

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# 1 INTRODUCTION

## High Performance Power Instrumentation

The 3720 ACM is a microprocessor-based, digital 3-phase "Smart Power Monitor/Meter" designed for use in industrial, commercial, and utility power distribution switchboards and substations. The 3720 ACM answers the ever-increasing concern for 'clean', reliable power by integrating the many critical aspects of power monitoring, analysis, and control into one simple and economical instrument. It is a state of the art alternative to traditional analog electromechanical metering devices, replacing numerous individual transducers and meters, and offering many features previously unavailable in power instrumentation.

The 3720 ACM offers the high accuracy, reliability, and ruggedness of its companion product, the successful 3710 ACM, while adding many new measurements and advanced features (see Figure 1.1.1). The 3720 ACM also matches the 3710 ACM in its mounting dimensions, installation requirements, and in its straightforward and flexible user interface.

The unit is based around a 13.5 MHz, 16 bit microcontroller chip. This provides very high computational throughput, allowing the unit's sophisticated software to process information in real time. The unit is self-contained and its readings and set up parameters are maintained in nonvolatile memory. An internal 16-bit CPU gives the 3720 ACM the processing capability to be used as a stand-alone power monitoring and control station or as a *smart RTU* in a large energy monitoring network.

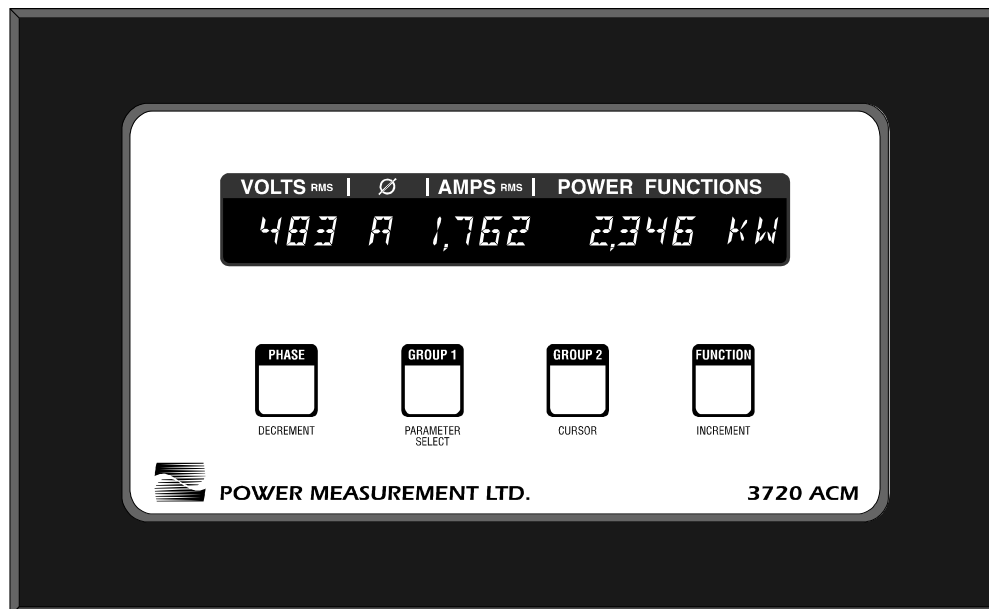
## Easy Installation and Exceptional Ruggedness

The 3720 ACM is panel-mountable and provides rear-mounted, utility approved terminal strips rated at 600V. The 3720 ACM is exceptionally rugged, with a high tolerance to electrical disturbances and temperature extremes. Many special design features guarantee performance in electrically harsh environments. The voltage, current, status (digital), relay, supply power, and communications inputs are designed to withstand hipot, C37.90A SWC, and fast transient tests. The 3720 ACM transformer-coupled current inputs are fully isolated with respect to the chassis of the unit, and provide 300 Amp surge protection.

## Inputs and Outputs

The 3720 ACM supports a variety of power distribution configurations, including 4-wire Wye, 3-wire Delta, and Single Phase systems. 3 phase voltage and 3 phase current inputs are provided, as well as an additional current input. In installations with non-linear loads, where odd harmonics can fail to cancel, significant currents in the neutral conductor can be produced. The 3720 ACM fourth current input can be used optionally for monitoring current in the neutral conductor, or for ground current monitoring. Used in conjunction with its high-speed setpoint system, the 3720 ACM can provide reliable ground fault protection.

No intermediate transducers are required on phase voltage and current inputs. When equipped with the appropriate voltage input option, no PTs are required for Wye systems up to 347 VAC line-to-neutral / 600 VAC line-to-line. For higher voltage Wye systems, and all Delta systems, PTs can be used. The transformer-coupled current inputs accept CTs with 5 Amp full scale outputs. A 1 Amp input version is also available. Overrange measurement options include 125% to 1000%.



**Figure 1.1.1 3710 ACM vs. 3720 ACM Feature Comparison**

	<b>3710 ACM</b>	<b>3720 ACM</b>
INPUTS & OUTPUTS	3 phase voltage inputs, 3 phase current inputs, neutral/ground current input, 3 relay outputs, 4 digital inputs with pulse counter on 1 input (maximum pulse count frequency: 0.3 Hz), 1 analog voltage input, 1 analog current output.	3 phase voltage inputs, 3 phase current inputs, neutral/ground current input, 3 relay outputs, 4 digital inputs with scalable pulse counters on all 4 inputs (maximum pulse count frequency: 10 Hz), 1 analog voltage input, 1 analog current output.
MEASURED PARAMETERS	Over 70, including sliding window demand on 2 values, and min/max on all values.	Over 700, including harmonic distortion, K-Factor, and time-of-use. Min/max on all values. Thermal, sliding window and predicted demand on all values.
WAVEFORM CAPTURE	Yes. Triggers: comm. port.	Yes. Triggers: comm. port or setpoint.
WAVEFORM RECORDING	No.	Yes. Triggers: comm. port or setpoint.
SNAPSHOT (TREND) LOGS	Basic Model: 1 preset log with 12 parameters. Triggered by programmable time interval. 1200 data item capacity allows up to 25 hours of recording at 15 min. intervals. EMEM Option: Up to 12 definable parameters. 11,520 data item capacity allows 3 parameters to be recorded for 40 days at 15 min. intervals.	Basic Model: 8 programmable logs. Up to 12 definable parameters each. Triggered by programmable time interval or setpoint. 11,520 data item capacity. Memory allocation for each log is user-definable. 1 log is definable as high-speed. Can record at 2 cycle intervals, with definable stop conditions.
EVENT LOG	Basic Model: 50 records. Resolution: 1 sec. EMEM Option: 100 records.	Basic Model: 100 records. Resolution: 1 msec.
MINIMUM / MAXIMUM LOGS	1 preset log records min/max for all parameters.	1 preset log, plus 16 programmable logs each with 1 trigger parameter and 15 coincident parameters.
SETPOINTS	17 standard speed. Trigger source and relay status stored in event log. Can be used to trigger relay control.	17 total: 11 standard speed, 6 high speed. Trigger source and subsequent action(s) stored in event log. Trigger relay control, snapshot log, waveform capture, and/or waveform recorder.
COMMUNICATIONS	Selectable RS-232 / RS-485.	Selectable RS-232 / RS-485. Optional multiport comm card supports one RS-232 and two RS-485 ports (MPCC), or one RS-232, one RS-485 and one Ethernet port (MPE).

An auxiliary voltage input can be used to measure an external variable such as transformer temperature or battery voltage. Input range is 0 to 1 VAC. An auxiliary analog current output can provide 0-20 or 4-20 mA proportional to any measured parameter.

Four digital inputs can be used to monitor breaker status, ground fault relay status, or any other external dry contact. These can also be used as pulse counters to measure device cycles, running hours, etc. An internal 30 VDC supply provides self-excitation for “volts free” contact sensing.

Outputs include three on-board relays that can be automatically controlled by an extensive user-programmable setpoint system, or manually operated by commands made via the communications port. Relays can perform operations ranging from simple alarm activations to fully automated demand, power factor, or load control. Relays can operate in a *latched* or *pulse* mode, and can also be programmed to provide kWh (import/export), kVARh (import/export), or kVAh output pulsing. The basic 3720 ACM provides 10 Amp, Form C electromechanical relays. The SSR option provides 1 Amp, SPST solid state relays which offer longer lifetimes in continuous pulsing applications.

## Displays and Measurements

The 3720 ACM offers hundreds of high accuracy real-time, 3-phase measured parameters and status parameters. All parameters are quickly accessible via the front panel display or through the meter's communications port.

Real-time measurements include: Volts, Amps, Neutral/Ground Current, kW, kVA, kVAR, Power Factor, and Frequency. On-board power quality analysis capability offers total harmonic distortion, individual harmonics levels, and K-Factor for all eight voltage and current inputs (to the 15th harmonic).

Thermal, sliding window and predicted sliding demand are provided on all measurements. Minima/maxima values are also provided on all measurements.

Energy values include kWh, kVAh, and kVARh. All energy readings provide bidirectional (import/export) indication. All voltage, current, power and energy readings are true RMS, including harmonics.

An extensive time-of-use system allows you to configure each day of a 2 year calendar choosing from up to 16 daily profiles. Each profile supports up to 8 tariff changes per day, with 15 minute resolution.

You can define 3 demand registers and 3 energy registers which are available for use by 10 programmable tariffs. A *penalty tariff* can also be activated at any time by a level transition to one of the status inputs.

Status information includes real-time conditions for the three on-board relays, four status/counter inputs, and seventeen user-programmable setpoints. The scaling for each pulse counter reading is user-definable. Also included is internal self-diagnostic information.

## Unique and Flexible User Interface

The 3720 ACM front panel features a large, high-visibility, 20-character vacuum fluorescent display. Voltage, current and power functions can all be displayed together for the selected phase. Very large measured values with up to 9 digits of resolution (i.e. kWh) are presented using the entire display. Concurrent display of all three phases of voltage and current readings is also possible.

The 3720 ACM uses four long-life, stainless steel membrane switches to access all measured parameters and status information, and for programming functions. Using the **GROUP** buttons, you can define convenient *custom groupings* of important parameters for quick viewing.

You can program the basic setup parameters of the 3720 ACM quickly and easily from the front panel. Basic parameters include voltage and current scales, voltage mode (wye, delta, etc.), baud rate, etc.

Programming for many of the advanced features of the 3720 ACM must be performed via the communications port using a portable or remotely located computer running POWER MEASUREMENT's SCADA software (M-SCADA, L-SCADA or PowerView), or any compatible third-party software. These parameters include setup for waveform, data logging, and setpoint functions. Setup for the time-of-use registers is performed using POWER MEASUREMENT's WinTOU Setup utility.

Setup and other critical information is saved when 3720 ACM power is turned off. All programming is password protected.

## High-Speed Setpoint System

The comprehensive on-board setpoint system of the 3720 ACM provides extensive control over the three on-board relay outputs, as well as triggering capabilities for the waveform capture, waveform recorder, and snapshot logging features. Setpoints can also be used to automatically clear status input counters, or to reset time-of-use registers or Min/Max Logs.

Seventeen user-programmable setpoints are provided, six of which offer high-speed (67 msec / 4 cycle) capabilities. Setpoints can be activated by a wide variety of conditions, including

- A user-defined level on any measured parameter, such as voltage, current, power, harmonic distortion (HD), demand, etc.
- Time-overcurrent characteristics.
- External equipment status (via the status inputs).
- New hour, day, week, month or year.

An active setpoint condition can be used to trigger simultaneously up to two separate functions. For example you may wish to operate a relay and perform a waveform recording when an overcurrent condition occurs. Using predicted demand, you can apply setpoint control of the on-board relays in effective demand management strategies.

All setpoint activity is recorded automatically in the on-board Event Log.

## Power Quality Monitoring and Fault Recording

Beyond its on-board harmonic distortion and K-Factor measurements, the 3720 ACM has also been equipped with digital waveform sampling capabilities for power quality monitoring and fault analysis. The 3720 ACM provides two powerful methods for acquiring waveform data: *waveform capture* and *waveform recording*.

**WAVEFORM CAPTURE**

Waveform capture allows you to perform high-speed (128 samples/cycle) sampling of the eight voltage and current inputs, providing high-resolution data which can be used for detailed power quality analysis. Capture can be triggered either through user-defined setpoint conditions, or commands via the meter's communications port. Sampled waveform data is stored in on-board memory and can be read via the communications port. POWER MEASUREMENT's SCADA PC-based software automatically uploads captured waveform data. You can then retrieve the waveforms for display and analysis. The SCADA software calculates total harmonic distortion, Crest Factor and K-Factor for each waveform and a breakdown of individual harmonic components (to the 63rd harmonic) both in graphical and tabular form.

**WAVEFORM RECORDER**

Waveform recording allows you to analyze the conditions occurring before, during, and after a power fluctuation or failure and is ideal for fault and surge analysis, and to aid in fault location.

Waveform recording runs continuously at 16 samples/cycle on all eight voltage and current inputs. A trigger by a user-specified setpoint condition or a command made via the meter's communications port freezes multiple cycles of each waveform in memory along with a time stamp.

The user can configure the 3720 ACM to concurrently store on-board up to three 12-cycle events, two 18-cycle events, or one 36-cycle event for each input. A programmable trigger delay allows pre-event or post-event data to be recorded.

The recorded data is saved until uploaded to a master station for analysis. POWER MEASUREMENT's SCADA software can be used to display the waveforms together on the computer screen, presenting a comprehensive picture of the power line conditions surrounding the disturbance.

**On-Board Data Logging**

The 3720 ACM supports three types of on-board data logging. Logged data can be extremely useful in the study of growth patterns, for scheduling loads and for cost allocation, for isolating problem sources, or for analyzing a variety of power system operating conditions.

**EVENT LOGGING**

The Event Log provides 100 date and time-stamped records. Digital input changes are recorded with 1 millisecond accuracy, ideal for sequence-of-event recording. The log also records all relay operations, setpoint/alarm conditions, setup changes, and self-diagnostic events.

**MINIMA/MAXIMA LOGGING**

A Preset Min/Max Log records the extreme values for all parameters measured by the 3720 ACM, including all voltage, current, power, frequency, power factor, harmonic distortion, and demand values. Minima/maxima for each parameter are logged independently with date and time stamp, with 1 second resolution.

16 Programmable Min/Max Logs allow you to define up to 16 separate logs, each containing up to 16 time-stamped parameters. Each log is triggered by the first parameter in its list. When a new minimum or maximum for the trigger parameter is recorded, coincident real-time values for all other parameters in the list are simultaneously stored. For example, you could program a log to record all per-phase kW, kVAR, and PF demand values when total kW demand peaks. Reset functions for the preset and programmable Min/Max Logs are performed either from the front panel or via communications.

**HISTORICAL LOGGING**

The 3720 ACM Snapshot Logs are *historical* or *trend* logs. Up to 8 logs may be defined, each recording up to 12 channels of time-stamped data. The measured parameters recorded by each log are user-programmable.

Each Snapshot Log can be triggered in one of three possible ways. Trigger functions are assigned independently for each log.

- A user-defined *time interval* basis provides an interval range from 1 second to 400 days. One log can be also configured for *high-speed* operation, recording at intervals as short as 2 cycles. The high-speed log can be useful for logging short duration conditions, such as motor start-ups, etc.
- A *1-shot* method allows any standard setpoint to automatically trigger a snapshot recording when an active condition occurs. Setpoint conditions can include harmonic distortion levels, status input changes, and more.
- A *gated* method allows readings to be recorded on a time interval basis only during the time that a setpoint remains active. This method is ideal for logging voltage and current extremes following a breaker trip, for example.



**ACCESS TO LOGGED DATA**

Alarm conditions, events, min/max levels, and snapshot interval readings are all automatically time-stamped and logged into on-board nonvolatile memory and are accessible via the communications port. Preset Min/Max Log readings can also be viewed via the front panel display by assigning them to either GROUP button.

POWER MEASUREMENT's SCADA software can be used to program all log setup parameters, and to display all logged data. Historical snapshot data can be displayed graphically. The SCADA software also automatically archives to disk all logged data retrieved from each remote device. Data can be converted into formats compatible with a wide range of third-party database and spreadsheet applications.

**Remote Communications**

The 3720 ACM is equipped with a selectable RS-232 or RS-485 communications port which allows the 3720 ACM to be integrated within large energy monitoring networks. 3720 ACM communications uses an advanced object and register based open protocol which allows the 3720 ACM to be easily adapted to third-party PLC, DCS, EMS, and SCADA systems.

The optional multiport communications cards expand the communications capabilities of the 3720 ACM. The MPCC equips the 3720 ACM with one RS-232 and two RS-485 ports, while the MPE equips the 3720 ACM with one RS-232, one RS-485 and one Ethernet port. Refer to sections 2.6.3.a and 2.6.3.b for details.

**PC-Based SCADA**

The 3720 ACM maintains compatibility with POWER MEASUREMENT's PC-based *supervisory control and data acquisition* software, M-SCADA, L-SCADA, and PowerView and the entire family of 3000 series digital instrumentation, which includes power meters, power demand controllers, and smart transducer interfaces. A single M-SCADA station can support up to 99 remote sites with a total of 3168 devices. L-SCADA supports 1 site with 12 devices. Systems are easily expandable, and very large systems can be built by linking multiple master stations.

POWER MEASUREMENT's SCADA software provides extensive full-color data display options, automated data handling and system control features including: real-time data display for all or part of the power system; display of captured waveforms and harmonic analysis; historical trend graphing; detection, annunciation, display and logging of alarm conditions; and automatic retrieval and disk archival of data logs from remote devices. With the SCADA system, power monitoring, load trending, and harmonic or fault analysis can

be performed concurrently with other system supervisory functions, eliminating the need for costly manual surveys using portable instruments.

The POWER MEASUREMENT approach to SCADA guarantees consistently accurate data retrieval by delegating extensive data acquisition, data logging, and control capabilities to the remote meter/RTU sites. Less processing requirements at the master station means high reliability and performance. Nonvolatile data logs ensure data is always retrievable following a temporary power or communication failure.

**Meter-to-Meter Time Sync**

Using the global time sync broadcast capability of POWER MEASUREMENT's SCADA software, all 3720 ACM devices connected on the same RS-485 bus can be time synchronized to a typical accuracy of  $\pm 1$  ms (max.  $\pm 10$  ms). This allows for 1 ms time-stamp accuracy on waveform capture and recorder data, and status input or relay activity in the 3720 ACM Event Log. Compatible third-party systems can also take advantage of this feature.


**System Applications**


Because of its unique measurement, storage, setpoint control (load shedding) and display characteristics the 3720 ACM should be considered for use in:

- Utility Installations
- Industrial Buildings
- Office Buildings
- Commercial Buildings
- Hospitals
- Telephone Exchanges
- Factories
- Pulp Mills
- Saw Mills
- Shopping Centres
- Large Stores
- Hotels
- Substation Metering
- Co-generation Systems
- Chemical Process Plants
- Multi-user sites where allocation of electrical costs is desirable
- Any other installation which uses significant amounts of electrical energy.
- Any other installation which is experiencing power quality problems.
- Any other locations where remote power monitoring, control, or analysis is needed.



2 INSTALLATION



**DANGER**

During normal operation of this device, hazardous voltages are present which can cause severe injury or death. These voltages are present on the terminal strips of the device and throughout the connected potential transformer (PT), current transformer (CT), and control power circuits. Installation and servicing should be performed only by qualified, properly trained personnel.

**CAUTION**

The 3720 ACM offers a range of hardware options that affect phase voltage, phase current, power supply, and relay input ratings. The rear panel label of the 3720 ACM lists all equipped options. Appendices D and E define all options and their associated ratings. This chapter provides detailed installation instructions applicable to each hardware option.

2.1 LOCATION & MOUNTING

Environmental Conditions

The 3720 ACM should be mounted in a dry, dirt free location away from heat sources and very high electric fields. Once installed, no cleaning of the device is necessary. To operate properly and effectively, environmental conditions should fall within the guidelines listed in Figure 2.1.1.

Enclosure Considerations

The enclosure the 3720 ACM is mounted in (typically a switchgear cabinet) should protect the device from atmospheric contaminants such as oil, moisture, dust, and corrosive vapors, or other harmful airborne substances.

The mounting enclosure should be positioned such that the doors may be opened fully for easy access to the 3720 ACM wiring and related components to allow for convenient troubleshooting. When choosing the enclosure size, allow for extra space for all wiring, intermediate terminal strips, shorting blocks, or any other required components.

3720 ACM Mounting

The front bezel of the basic model is moulded plastic, while that of the 3720 ACM-TRAN model is a flat metal plate. Bezel dimensions differ significantly between the two models. All other dimensions are similar.

BASIC MODEL

Appendix A provides the mounting dimensions for the 3720 ACM. The basic model 3720 ACM (i.e. with display) may be panel mounted for easy access and viewing, and provides four mounting studs to facilitate this. A 5 inch depth is required behind the front panel.

**WARNING**

Some electrical codes may prohibit extending voltages greater than 120 VAC line-to-neutral / 208 VAC line-to-line to the door of the switchgear cabinet. If this is the case, use a basic model (120 VAC input) 3720 ACM with PTs that provide 120 VAC secondaries (see Section 2.5).

TRAN MODEL

The 3720 ACM TRAN model is a displayless version that can be mounted flush against any flat surface using the four mounting holes provided. The unit can also be mounted through a panel cutout originally made for a basic model 3720 ACM, if desired.

Figure 2.1.1 Environmental Guidelines for Installation

ENVIRONMENTAL CONDITION	ACCEPTABLE RANGE	
	3720 ACM	3720 ACM -XTEMP
Operating Temperature	0°C (32°F) to 50°C (122°F)	-20°C (-4°F) to +70°C (158°F)
Storage Temperature	-30°C (-22°F) to +70°C (158°F)	
Relative Humidity	5 to 95% non-condensing	



**CAUTION**

A switch or circuit breaker should be included in the installation, in close proximity to the unit and within easy reach to the operator. This switch or circuit breaker should be marked as the disconnecting device for the unit.

## 2.2 GENERAL WIRING CONSIDERATIONS

Connections to the 3720 ACM are made to two terminal strips located on the rear of the unit. Appendix A provides 3720 ACM terminal block dimensions. 12 to 14 gauge wire is recommended for all connections. Ring or spade terminals may be used to simplify connection.

**CAUTION**

1. All wiring must conform to any applicable local electrical codes, and device terminals (once installed) should not be user accessible.
2. In applications where the on-board relays are being used to perform critical equipment control operations (e.g. breaker trip, etc.), special precautions are required. See Section 2.7.

### 2.2.1 FIELD SERVICE

If the 3720 ACM requires servicing or field upgrading, you may need to disconnect and remove the unit from its mounting. The initial installation should be done in a way that makes this as convenient as possible:

- All phase voltage sense leads should be protected by breakers or fuses at their source such that the 3720 ACM can be safely disconnected.
- A CT shorting block should be provided so that the 3720 ACM current inputs can be safely disconnected without open circuiting the CTs. The shorting block should be wired so that protective relaying is not affected.
- All wiring should be routed to allow easy removal of the connections to the 3720 ACM terminal strips, the 3720 ACM cover, and the 3720 ACM itself.

## 2.3 POWER SUPPLY CONNECTIONS

### Power Supply Options

#### BASIC MODEL

The basic model 3720 ACM can be powered by 100 to 240 VAC ( $\pm 10\%$ ) or 110 to 300 VDC at 0.2 Amps. Power supply options are also available. The label on the rear panel indicates if the unit is equipped with one of these options.

#### P24/48 OPTION



This option can be powered by 20 to 60 VDC at 15 Watts.

### Power Sources and Connections


The basic model can be powered from a dedicated fused feed, or from the voltage source which it is monitoring, as long as it is within the supply range. The P24/48 option must be powered from a dedicated fused feed. If an AC power supply is being used, connect the line supply wire to the 3720 ACM L/+ terminal and the neutral supply wire to the N/- terminal. If a DC power supply is being used, connect the positive supply wire to the 3720 ACM L/+ terminal and the negative (ground) supply wire to the N/- terminal.


## 2.4 CHASSIS GROUND CONNECTION

The chassis of the 3720 ACM must be connected to earth ground. A good, low impedance chassis ground connection is essential for the 3720 ACM surge and transient protection circuitry to function effectively. It should be made to the switchgear earth ground using a dedicated 14 gauge (or larger) wire to a point where there will be no voltage error due to distribution voltage drops. Do not rely on metal door hinges as a ground path.

Ground wire connection to the chassis is made using the supplied ground lug. For the basic model, this is attached to one of the four mounting studs to form the protective ground terminal . For the TRAN model, the lug is attached to one of four mounting bolts to form the protective ground terminal .

**NOTE**

The VAUX input and IOUT output operate with reference to chassis ground. Do not use the protective ground terminal  to connect the VAUX or IOUT functional ground.

Ensure that the protective ground terminal  screw is tightened down securely onto the ground wire, and that the nut has been tightened down securely onto the lug.

**CAUTION**

The 3720 ACM chassis ground lug must be connected to the switchgear earth ground using a dedicated 14 gauge (or larger) wire for the noise and surge protection circuitry to function correctly. Failure to do so will void the warranty.

**2.5 PHASE VOLTAGE AND PHASE CURRENT INPUT CONNECTIONS**

**2.5.1 PHASE VOLTAGE INPUTS**

**Maximum Terminal Voltages**

The maximum constant voltage levels the phase voltage inputs can withstand are as follows:

Voltage Option	Maximum Terminal Voltage
120	150 VAC line-to-neutral, or 260 VAC line-to-line
277	346 VAC line-to-neutral, or 600 VAC line-to-line
347	434 VAC line-to-neutral, or 750 VAC line-to-line

**V1 Input Connection**

The 3720 ACM uses the V1 input as the reference for maintaining phase relationships for all power and energy related measurements. For any system configuration, the V1 input must be connected to ensure accurate readings and the correct operation of the 3720 ACM.

**Direct Connection**

Whether or not potential transformers (PTs) are required depends on the nature of the system being monitored, the voltage levels to be monitored, and the input option of the 3720 ACM.

**BASIC MODEL**

The basic model can be used for direct connection to Wye systems up to 120 VAC line-to-neutral / 208 VAC line-to-line or Single Phase systems up to 120 VAC line-to-neutral / 240 VAC line-to-line.

**277 OPTION**

This option provides 277 VAC full scale inputs that can be used for direct connection to Wye systems up to 277 VAC line-to-neutral / 480 VAC line-to-line or 277 VAC line-to-neutral / 554 VAC line-to-line Single Phase systems.

**347 OPTION**

Models supplied with the 347 option provide 347 VAC full scale inputs that can be used for direct connection to 347 VAC line-to-neutral / 600 VAC line-to-line Wye or Single Phase systems up to 347 VAC line-to-neutral / 694 VAC line-to-line.

**Using Potential Transformers**

If Wye system voltages are over 347 VAC line-to-neutral / 600 VAC line-to-line or Single Phase system voltages are over 347 VAC line-to-neutral / 694 VAC line-to-line, potential transformers (PTs) are required.

**NOTE**

PTs are always required for Delta systems.

PTs are used to scale down the line-to-neutral voltage of a Wye or Single Phase system, or the line-to-line voltage of a Delta system to the rated input scale of the 3720 ACM. The inputs of the basic model can be used with PTs that have secondaries rated at 120 VAC or less. This can include  $100/\sqrt{3}$ ,  $110/\sqrt{3}$ , 100, 110, or 120 VAC secondaries. Devices equipped with the 277 option can be used with PTs that have secondaries rated to 277 VAC, such as 220 VAC.

For proper monitoring, correct selection of PTs is critical. For Wye systems, the PT primary rating should equal the system line-to-neutral voltage or nearest higher standard size. For Delta systems, the PT primary rating should equal the system line-to-line voltage. For all system configurations, the PT secondary rating must be within the rated full scale range of the 3720 ACM voltage inputs.

PT quality directly affects system accuracy. The PTs must provide good linearity and maintain the proper phase relationship between voltage and current in order for the voltage, kW, and power factor readings to be valid. Instrument Accuracy Class 1 or better is recommended.

**2.5.2 PHASE CURRENT INPUTS**

The 3720 ACM uses CTs to sense the current in each phase of the power feed and (optionally) in the neutral or ground conductor. The selection of the CTs is important because it directly affects accuracy.

**Current Input Options**

The 3720 ACM offers various phase current input options to match the type of CTs being used and the desired overrange capability. The current input ratings of all three phase inputs and the I4 input are equivalent.

The basic model 3720 ACM is compatible with CTs with 5 Amp full scale secondaries. The 1AMP option provides compatibility with 1 Amp CT secondaries.

The basic model 3720 ACM provides 125% overrange capability which allows current readings to be accurately displayed up to 125% of full scale. For example, if the AMPS SCALE has been set at 2000 Amps full scale, the 3720 ACM allows for readings up to 2500 Amps.

The 3720 ACM provides three additional current input overrange options which include 200%, 500%, and 1000%. Note that each overrange option also affects all current-related measurement accuracies (Amps, kW, etc.) Refer to Appendix D for detailed specifications on each current input option.

### CAUTION

Refer to the rear panel label of the 3720 ACM to determine the equipped current input option(s). Applying current levels incompatible with the current input configuration will permanently damage the device.

### CT Ratings

The CT secondary should have a burden capacity greater than 3 VA.

The CT primary rating is normally selected to be equal to the current rating of the power feed protection device. However, if the peak anticipated load is much less than the rated system capacity, you can improve accuracy and resolution by selecting a lower rated CT. In this case the CT size should be the maximum expected peak current +25%, rounded up to the nearest standard CT size.



Other factors may affect CT accuracy. The length of the CT cabling should be minimized because long cabling contributes to inaccuracy. Also, the CT burden rating must exceed the combined burden of the 3720 ACM plus cabling plus any other connected devices (burden is the amount of load being fed by the CT, measured in Volt-Amps). The 3720 ACM burden rating is given in Appendix D.

Overall accuracy is dependent on the combined accuracies of the 3720 ACM, the CTs, and the PTs (if used). Instrument accuracy Class 1 or better is recommended.



### 2.5.3 PT & CT CONNECTION

Figures 2.5.7a to 2.5.9 illustrate all required phase voltage and phase current connections for various circuit configurations to ensure correct installation. Phasing and polarity of the AC current and voltage inputs and their relationship is critical to the correct operation of the unit.

All phase voltage sense leads should be protected by breakers or fuses at their source. In cases where PTs are required, if the power rating of the PTs is over 25 Watts the secondaries should be fused.

	 <b>DANGER</b>
	PT secondary circuits are capable of generating lethal voltages and currents with their primary circuit energized. Standard safety precautions should be followed while performing any installation or service on the device (e.g. removing PT fuses, etc.)

CTs should be connected to the device via a shorting block or test block to facilitate the safe connection and disconnection of the CTs.

	 <b>DANGER</b>
	CT secondary circuits are capable of generating lethal voltages and currents when open circuited with their primary circuit energized. Standard safety precautions should be followed while performing any installation or service on the device (e.g. shorting CT secondaries, etc.)

Refer all questions regarding proper working procedures to qualified personnel.

### 2.5.4 VOLTAGE REFERENCE CONNECTION

The voltage reference terminal,  $V_{REF}$ , of the 3720 ACM serves as the zero voltage reference for voltage readings. A good, low impedance  $V_{REF}$  connection is essential for accurate measurement. It should be made using a dedicated 14 gauge wire to a point where there will be no voltage error due to distribution voltage drops.

The connection point for  $V_{REF}$  is dependent on the system configuration. Each of the following configurations is illustrated in Figures 2.5.7a to 2.5.9:

- If the system being monitored is 4-wire Wye or Single Phase,  $V_{REF}$  must be connected to the neutral conductor.
- If the system is 3-wire grounded (Delta),  $V_{REF}$  must be connected to the line transformer neutral.
- For 3-wire ungrounded (Open Delta) systems, and for systems where PTs are being used,  $V_{REF}$  must be connected to the PT common leads.

2.5.5 WAVEFORM CAPTURE CONNECTIONS

The 3720 ACM waveform capture feature allows signals at each of its voltage (V1, V2, V3, VAUX) inputs and current (I1, I2, I3, I4) inputs to be digitally sampled. The 3720 ACM uses the V1 input as the triggering reference for waveform capture, and to maintain phase relationships between all sampled signals. The V1 input must be connected for waveform capture to work. No other special wiring considerations are necessary. The operation of the waveform capture feature is described in detail in Chapter 6.

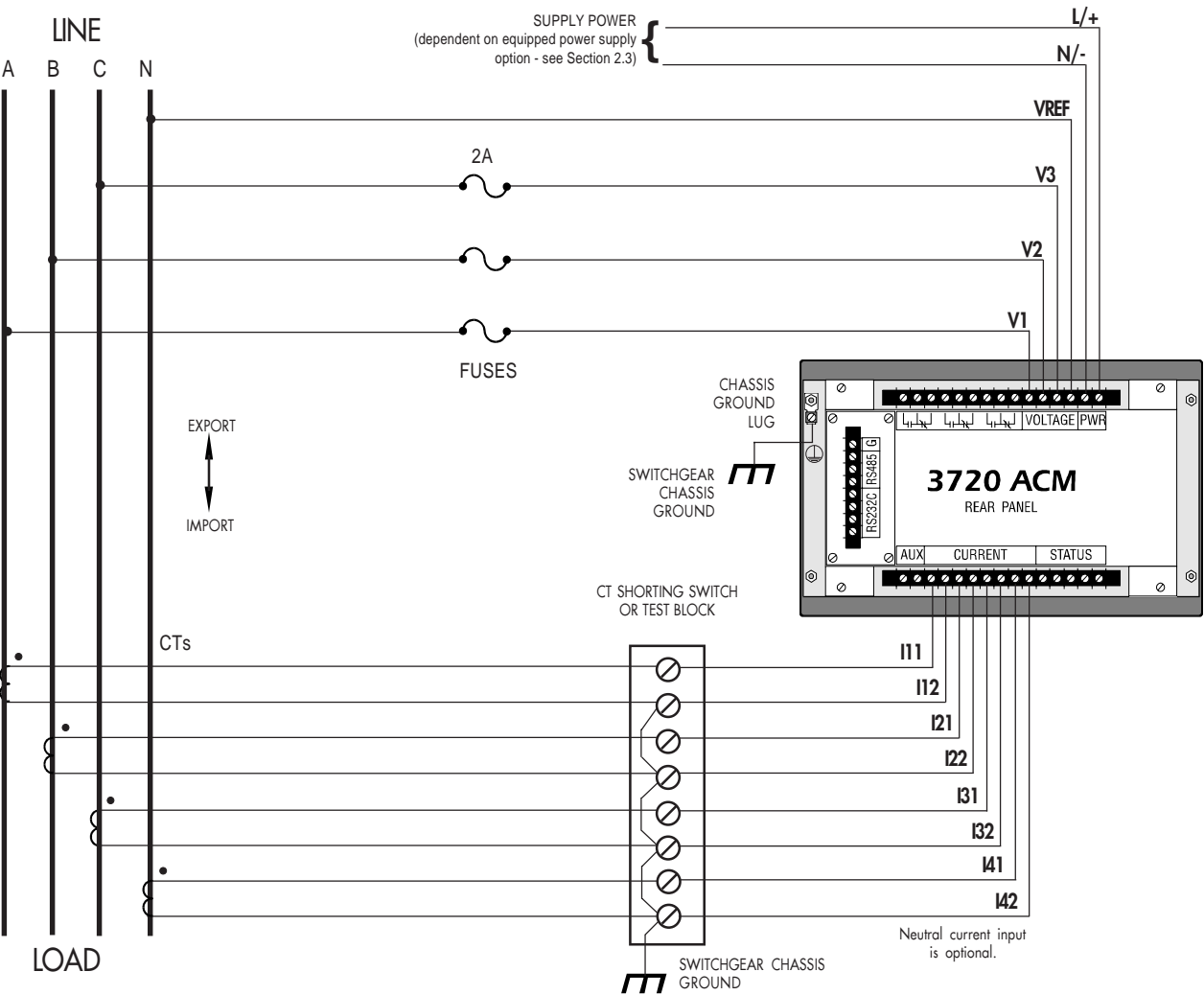
2.5.6 I4 CURRENT INPUT CONNECTIONS

The 3720 ACM is equipped with a fourth current input, named I4. This input is typically used to measure the current flow in the neutral or ground conductor. The use of this input is optional.

The secondary rating of the CT connected to the I4 input must be identical to that of the three phase current inputs. This rating depends on the current input option installed in the 3720 ACM.

The primary rating for the CT connected to the I4 input can be different than for the three phase inputs, since the I4 input scaling can be programmed independently.

Figure 2.5.7a 4 Wire Wye: 3 Element Direct Connect  
(For 120 VAC line-neutral / 208 VAC line-line to 347 VAC line-neutral / 600 VAC line-line Systems)



<b>VOLTS MODE:</b> 4W-WYE	<b>INPUT OPTION:</b> ≤ 120 VAC line-to-neutral / 208 VAC line-to-line Systems: Basic Model ≤ 277 VAC line-to-neutral / 480 VAC line-to-line Systems: 277 Option ≤ 347 VAC line-to-neutral / 600 VAC line-to-line Systems: 347 Option
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### 2.5.7 CONNECTION FOR THREE PHASE WYE (STAR) SYSTEMS

Figures 2.5.7a to 2.5.7d provide wiring diagrams for 4 and 3-wire Wye system configurations.

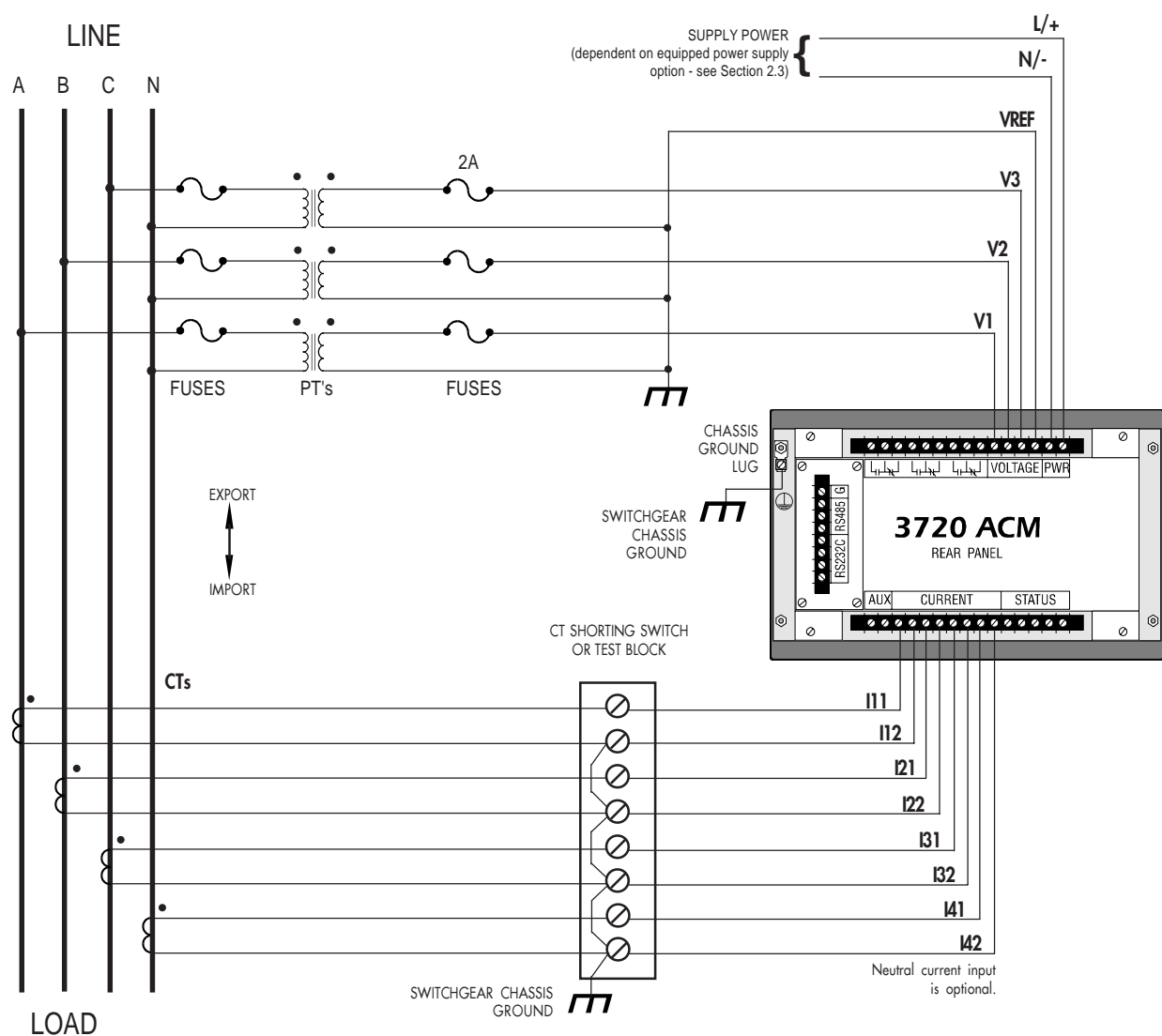
For a 4-wire Wye system, the 3720 ACM senses the line-to-neutral (or ground) voltage of each phase and current of each phase, making for an equivalent 3 element metering configuration.

If the power system to be monitored is a 120 VAC line-to-neutral / 208 VAC line-to-line system, the basic model with 120 VAC inputs can be used with direct sensing of each phase, without the need for PTs. If the system is a 277 VAC line-to-neutral / 480 VAC line-to-line or 347 VAC line-to-neutral / 600 VAC line-to-line system, models with the 277 or 347 input options (respectively) may be connected directly.

The wiring diagram for these voltage ranges is shown in Figure 2.5.7a below. VOLTS MODE should be set to 4W-WYE.

For Wye system voltages over 347 VAC line-to-neutral / 600 VAC line-to-line, PTs must be used. When PTs are used, both the PT primary and secondary must be wired in a Wye (Star).

Figure 2.5.7b 4 Wire Wye: 3 Element Connection Using 3 PTs



**VOLTS MODE:**  
4W-WYE

**INPUT OPTION:**  
Basic Model (120 VAC line-to-neutral / 208 VAC line-to-line)

Voltage sense leads should be protected by breakers or fuses at their source. Wiring must be exactly as shown for correct operation.

This configuration is shown in Figure 2.5.7b. VOLTS MODE should be set to 4W-WYE.

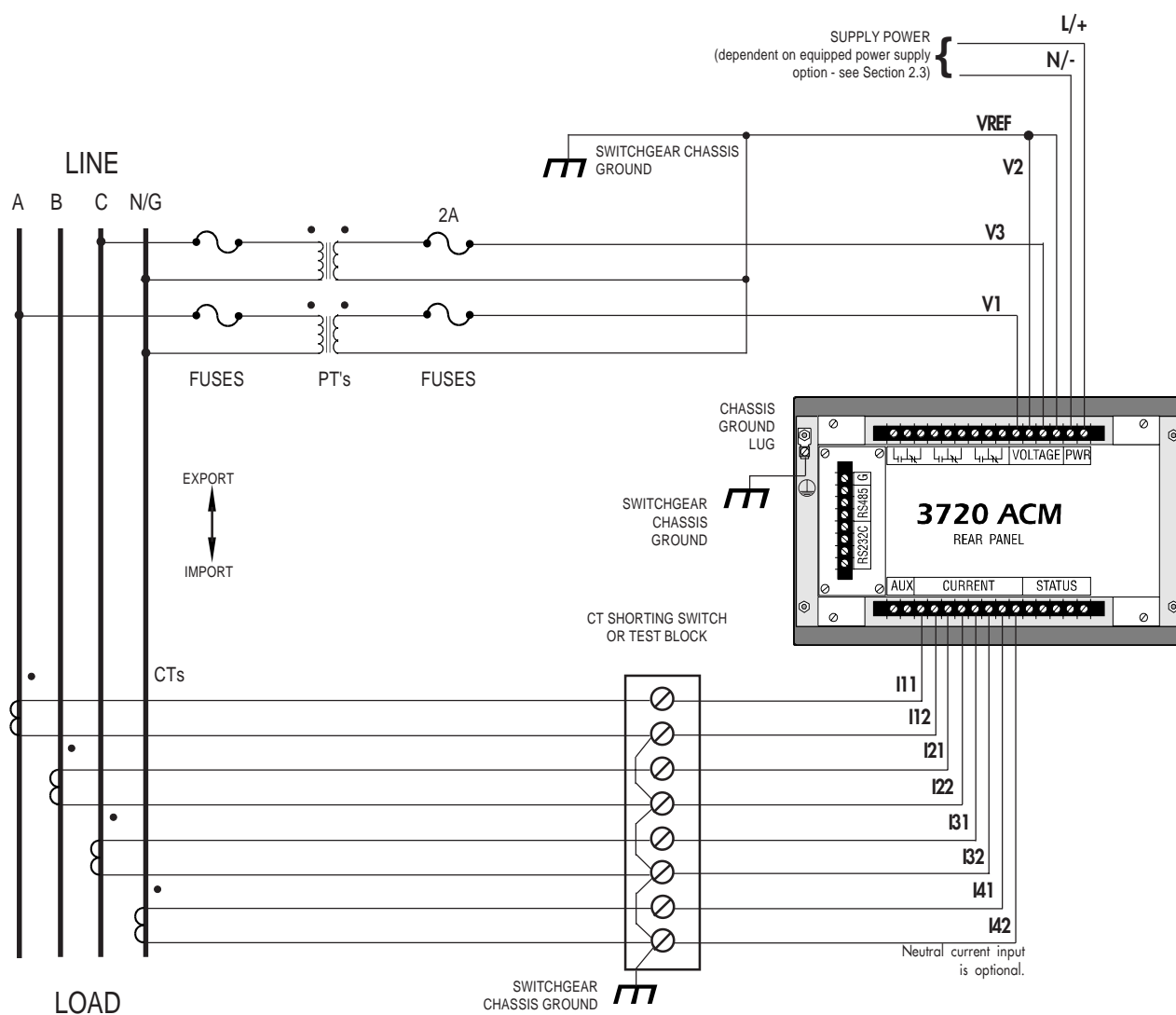
The 3720 ACM also supports a 2½-element connection scheme which requires only two PTs. In this mode, the phase B voltage displayed on the front panel is derived from the available voltages.

This configuration is shown in Figure 2.5.7c. VOLTS MODE should be set to 3W-WYE.

### WARNING

VOLTS MODE = 3W-WYE only provides accurate power measurement if the voltages are balanced. If the phase B voltage is not equal to the phase A and C voltages, the power readings may not meet the 3720 ACM accuracy specifications.

Figure 2.5.7c 4 Wire Wye: 2½ Element Connection Using 2 PTs



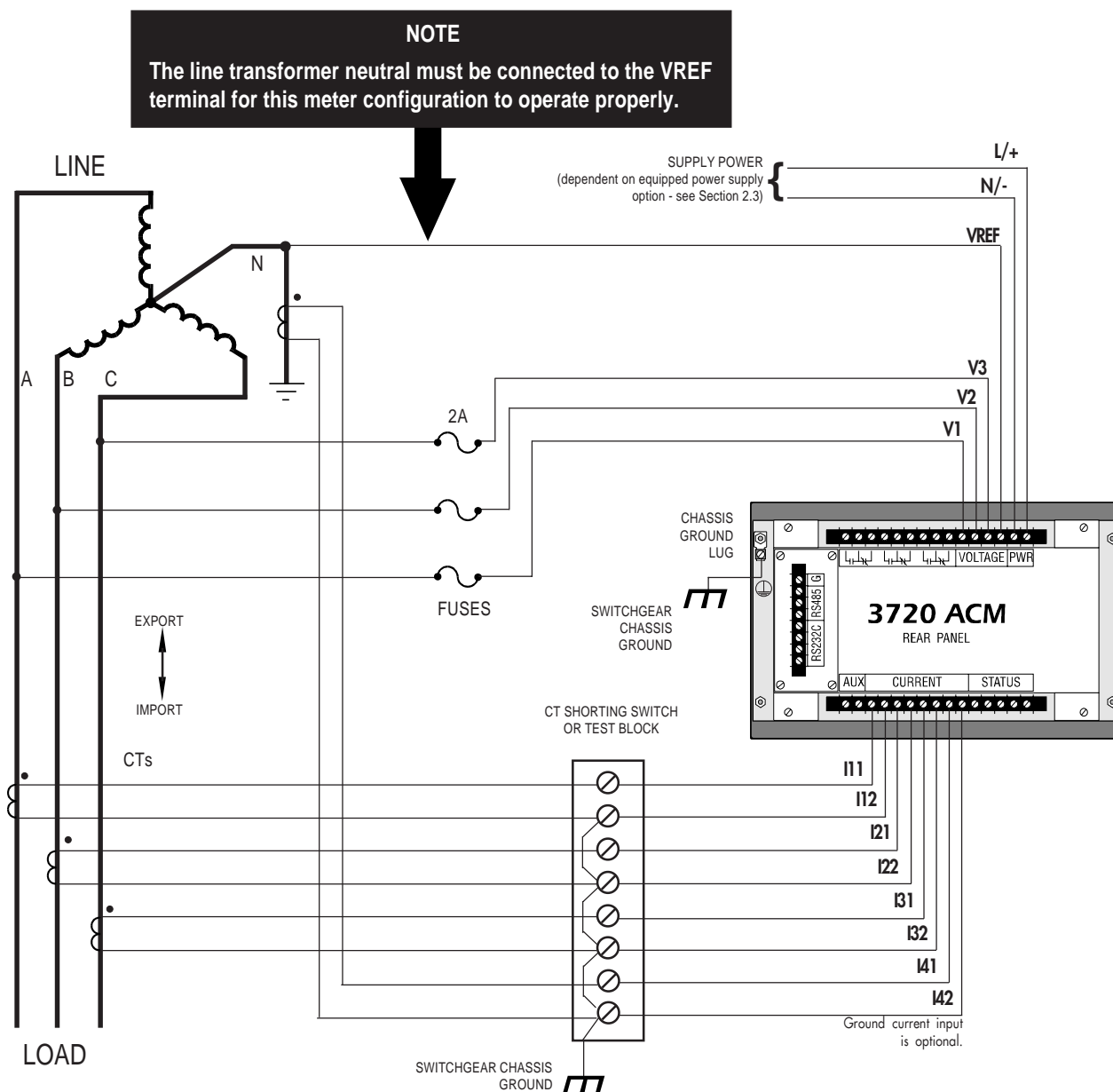
**VOLTS MODE:**  
3W-WYE

**INPUT OPTION:**  
Basic Model (120 VAC line-to-neutral / 208 VAC line-to-line)

When the common or *star* point of a 3 wire Wye system is grounded, the 3720 ACM may be connected directly without the use of PT's (provided the voltages are within the input range of the unit).

This configuration is shown in Figure 2.5.7d. The VOLTS MODE should be set to 4W-WYE.

**Figure 2.5.7d 3 Wire Grounded Wye: 3 Element Direct Connection**  
(For 120/208 to 347/600 Volt Systems)



**VOLTS MODE:**  
4W-WYE

**INPUT OPTION:**

≤ 120 VAC line-to-neutral / 208 VAC line-to-line Systems:  
≤ 277 VAC line-to-neutral / 480 VAC line-to-line Systems:  
≤ 347 VAC line-to-neutral / 600 VAC line-to-line Systems:

Basic Model  
277 Option  
347 Option

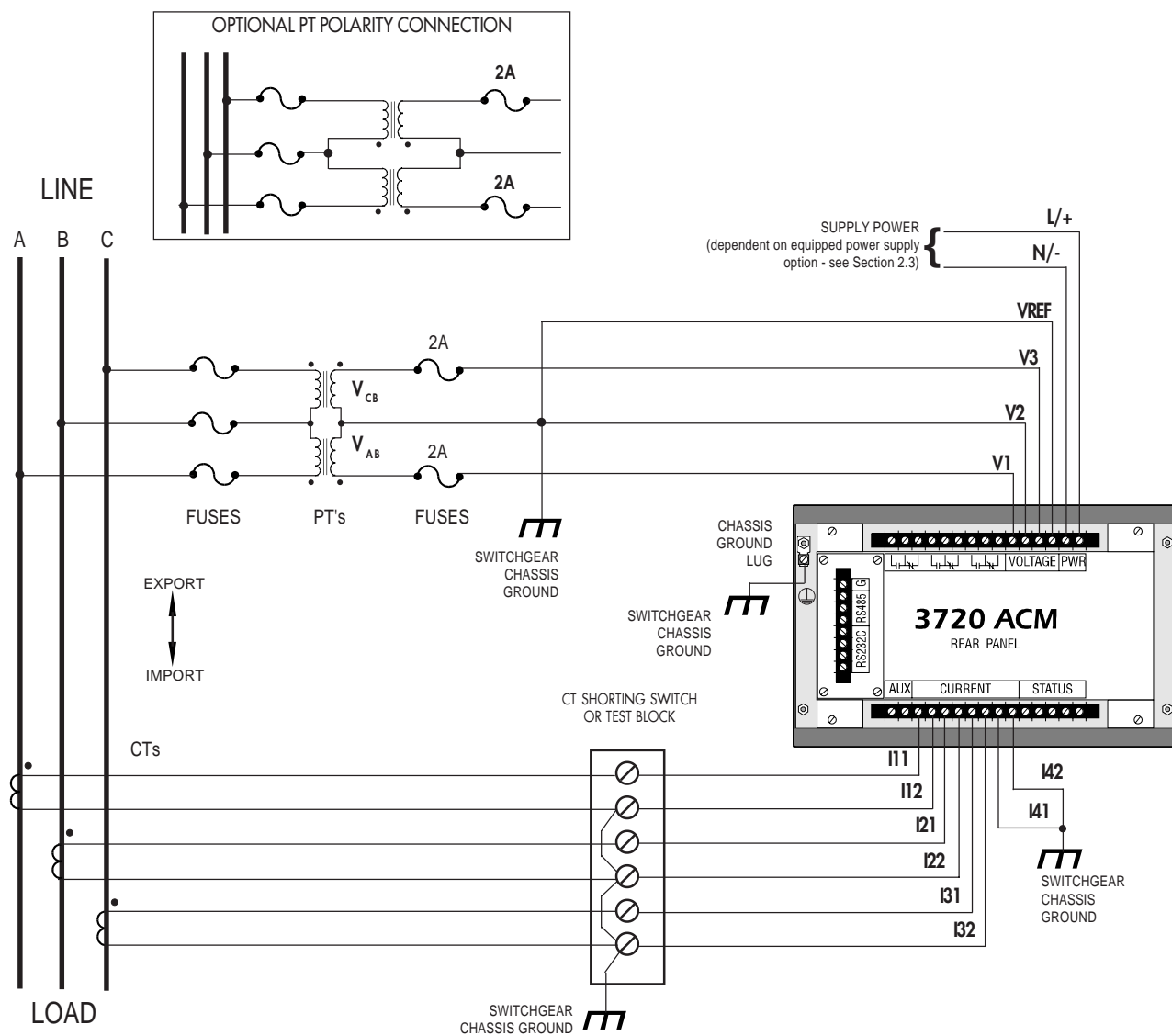


### 2.5.8 CONNECTION FOR THREE PHASE DELTA SYSTEMS

For ungrounded (floating) 3 wire Delta systems, the 3720 ACM always requires PTs and senses the line-to-line voltages between each of the phases.

The 3720 ACM may be connected in either of two ways: using 2 or 3 CTs. Figure 2.5.8a below shows ungrounded Delta connection using 3 CTs. VOLTS MODE should be set to DELTA.

Figure 2.5.8a 3 Wire Delta System: 2½ Element Connection Using 2 PTs and 3 CTs



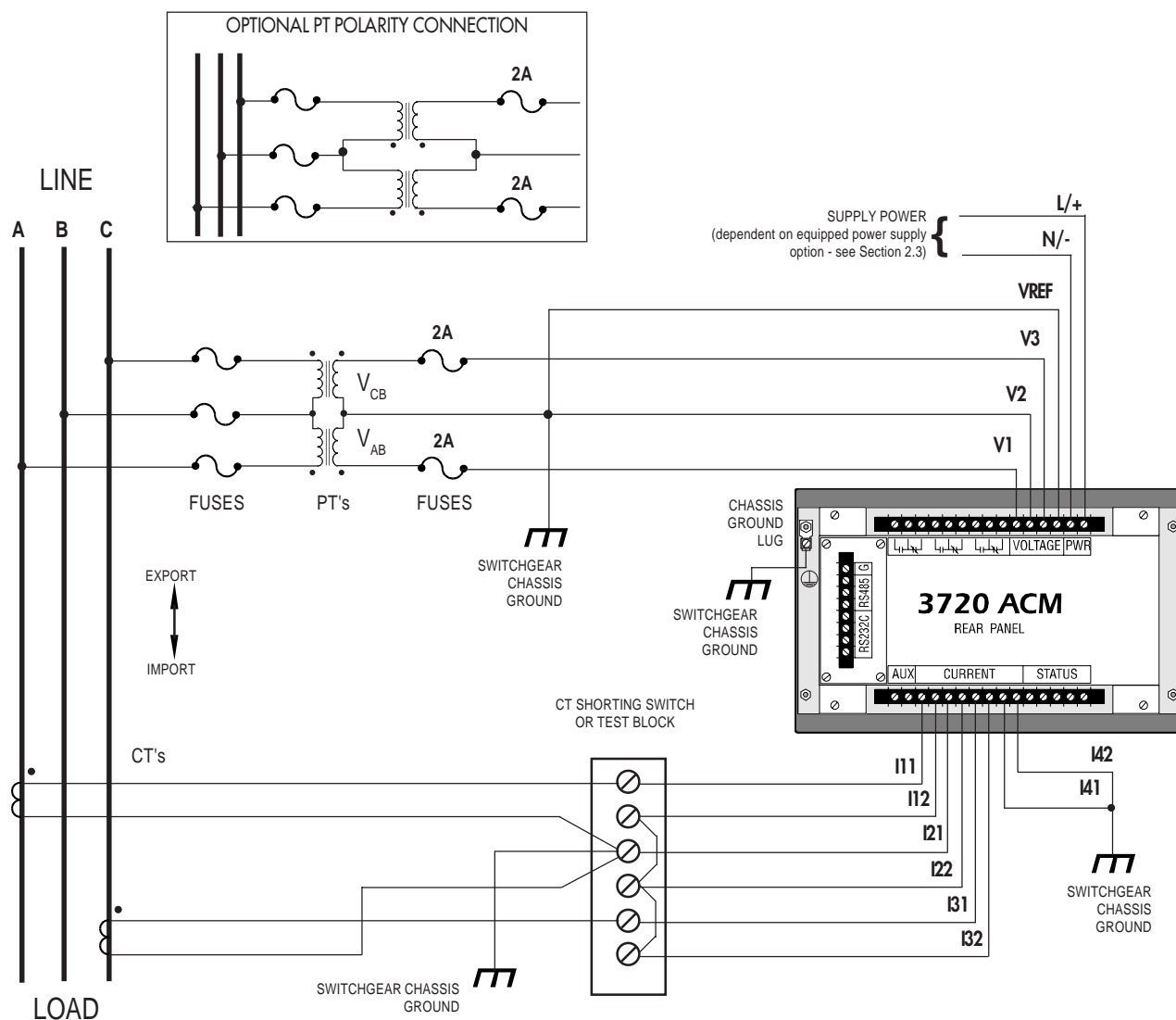
**VOLTS MODE:**  
DELTA

**INPUT OPTION:**  
Basic Model (120 VAC line-to-neutral / 208 VAC line-to-line)



Figure 2.5.8b below shows ungrounded Delta connection using 2 CT's. VOLTS MODE should be set to DELTA.

**Figure 2.5.8b 3 Wire Delta: 2 Element Connection Using 2 PTs and 2 CTs**



**VOLTS MODE:**  
DELTA

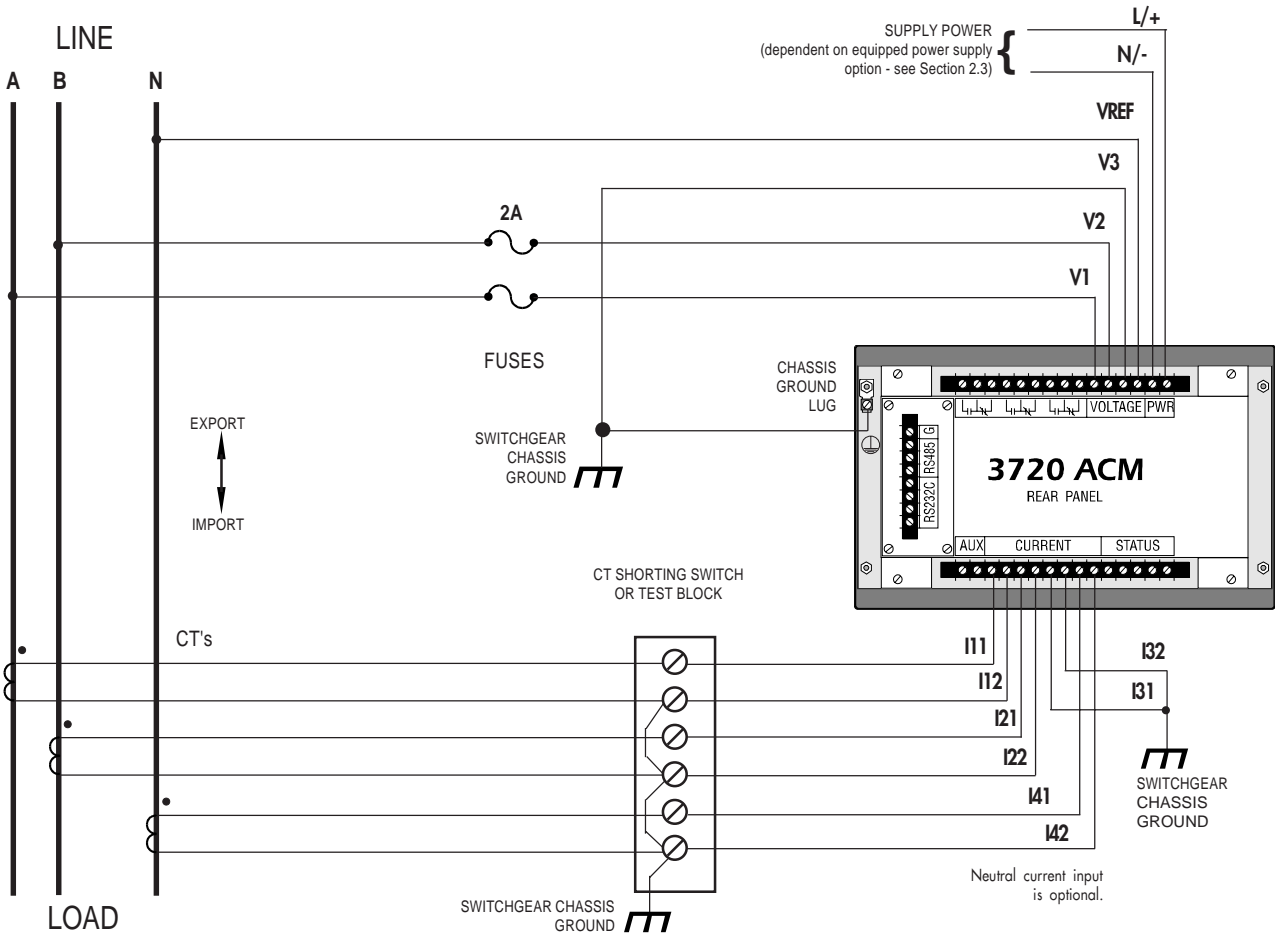
**INPUT OPTION:**  
Basic Model (120 VAC line-to-neutral / 208 VAC line-to-line)

2.5.9 CONNECTION FOR SINGLE PHASE SYSTEMS

Wiring for Single Phase systems is performed by connecting the two voltage phases (each 180 degrees with respect to each other) to the  $V_1$  and  $V_2$  inputs of the 3720 ACM, and the outputs of the two corresponding current transformers to the  $I_1$  input pair and  $I_2$  input pair.

This is illustrated in Figure 2.5.9 below. Note that the  $V_3$  input and  $I_3$  input pair are unused and should all be grounded. For Single Phase systems, the VOLTS MODE of the 3720 ACM should be set to SINGLE.

Figure 2.5.9 3 Wire Single Phase: 2 Element Direct Connection



<b>VOLTS MODE:</b> SINGLE	<b>INPUT OPTION:</b> $\leq 120$ VAC line-to-neutral / 240 VAC line-to-line Systems: $\leq 277$ VAC line-to-neutral / 554 VAC line-to-line Systems: $\leq 347$ VAC line-to-neutral / 694 VAC line-to-line Systems:	Basic Model 277 Option 347 Option
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## 2.6 COMMUNICATIONS CONNECTIONS

### 2.6.1 INTRODUCTION

The 3720 ACM comes equipped with an ISOCOM2 communications card as standard equipment. A Multi-Port Communications Card (MPCC) is also available as an option.

The following sections describe communications card configuration instructions and wiring requirements for direct or modem connection with a master computer station or other device. Refer to Chapter 9 for information regarding communications setup parameters.

### 2.6.2 ISOCOM2 COMMUNICATIONS CARD

The ISOCOM2 is a field configurable communications device that allows the 3720 ACM to transmit or receive data using either the RS-232 or RS-485 standard. Integrated optical coupling provides full isolation between the RS-232 or RS-485 communication lines and the metering equipment. Protection circuitry provides protection from common mode voltages and incorrect connection of the ISOCOM2. All inputs pass the ANSI/IEEE C37-90A-1989 surge withstand and fast transient tests.

#### IMPORTANT

The communications card is shipped with a label affixed to the mounting plate indicating the communications mode (RS-485 or RS-232) set at the factory. If the mode is incorrect for your application, see the following section.

### Configuring the Communications Card

The card has a jumper block allowing you to select RS-232 or RS-485 mode. The ISOCOM2 currently selected communications mode may be viewed from the front panel if the unit is operating (see Section 3.4 on Field Programming), or by removing the card and examining the position of the jumper block.

#### REMOVING THE CARD

##### CAUTION

Wear an anti-static wrist grounding strap at all times while performing any reconfigurations or modifications to the 3720 ACM. Failing to do so may permanently damage the static-sensitive components inside the meter.

1. Turn off the power to the 3720 ACM.
2. Remove the four machine screws holding the rectangular communications card mounting plate to the 3720 ACM case back cover.
3. Carefully pull the plate away from the main chassis to remove the card.

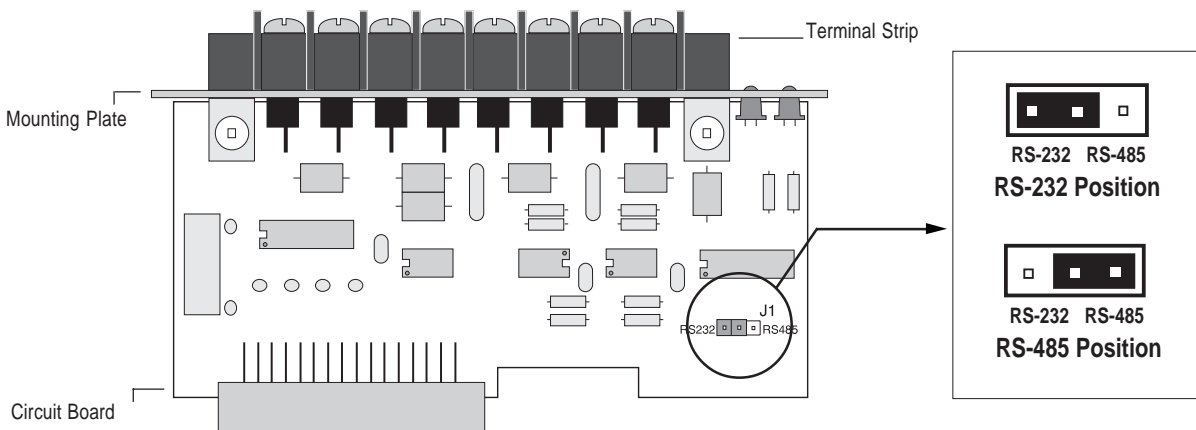
#### CONFIGURING THE CARD

The circuit board of the communications card has a jumper labelled J1. This jumper has two positions, labelled "RS485" and "RS232", which determine the communications mode. Figure 2.6.2a illustrates the jumper position required for RS-485 or RS-232 mode. Move the jumper to the correct position.

#### REINSTALLING THE CARD

1. Make sure that the power to the 3720 ACM is off.

Figure 2.6.2a Communication Card Jumper Configuration (ISOCOM2 Type)



2. Insert the communications card into the communications port, ensuring that the circuit card is oriented such that it will mate properly with the edge connector on the main board inside 3720 ACM.

**NOTE**

The card is polarized (keyed) to ensure it may only be installed in the correct orientation.

3. Align the holes in the mounting plate of the card with the mounting holes in the rear cover of the main chassis while lowering the card towards its seating. A correct alignment will allow the card edge to mate with the edge connector inside the main chassis.
4. Once the board is resting in proper alignment on the edge connector, carefully press down to plug the card into the edge connector.
5. Install the four mounting screws into the mounting plate to secure the card.

The card is now ready for use.

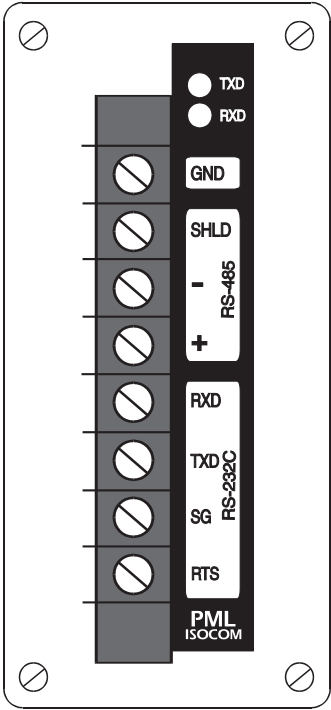
**Terminal and LED Functions**

The ISOCOM2 communications card provides a barrier-style terminal strip (see Figure 2.6.2b). Terminal functions include:

GND	Chassis Ground
SHLD	RS-485 Shield (electrically connected to chassis ground)
–	RS-485 Data Minus
+	RS-485 Data Plus
RXD	RS-232 Receive Data (i.e. data into device)
TXD	RS-232 Transmit Data (i.e. data out of device)
SG	RS-232 Signal Ground (isolated)
RTS	RS-232 Request To Send (optional, see Section 9.2)

Two LED indicators, **TXD** and **RXD**, show activity on the RS-485 or RS-232 communications lines and can be used to verify correct communications operation. The **TXD** indicator flashes when data is being sent out by the device. The **RXD** indicator flashes when data is being received by the device.

**Figure 2.6.2b** ISOCOM2 Card Terminal Block



**RS-232 and RS-485 Connections**

Refer to Sections 2.6.4 and 2.6.5 for all communications wiring.

2.6.3.a     **MULTI-PORT COMMUNICATIONS CARD (MPCC)**

The optional Multi-Port Communications Card allows the 3720 ACM to communicate via three distinct ports (one RS-232 and two RS-485) within a multi-protocol environment.

**NOTE**

Only one RS-485 port (Port C) remains functional if the Carrier Detect (CD) option is enabled. This is described below.

Each port can be configured to operate with any of the supported protocols (PML, Modbus, AB DF-1, Alarm Dialer). All ports can communicate simultaneously. Optical coupling provides full isolation both between the RS-232 and RS-485 communication ports, the two RS-485 ports, and the metering equipment. In addition, protection circuitry provides a safeguard from common mode voltages that may be applied to the card due to incorrect connection of the MPCC.

Connections to the card are made by way of the eleven pin “captured wire” connector located on top of the card (see Figure 2.6.3.a).

**Communications Ports**

**PORT A**

- Standard: RS-232, half duplex
- Baud Rates: 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps.
- Signaling: Supports RTS (Request To Send) and CTS (Clear To Send) handshaking.
- Protection: Withstand ANSI C37.90 fast transient.
- Fully isolated from Port C.

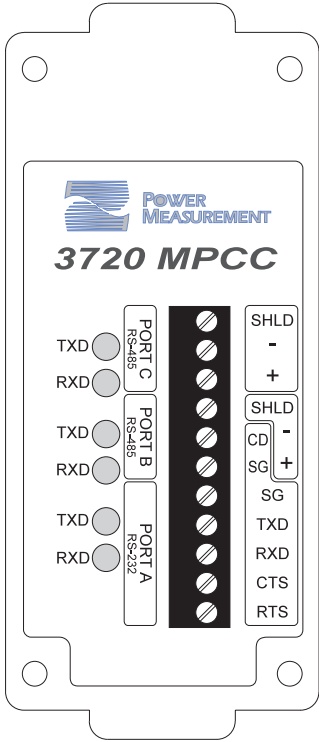
**PORT B**

- Standard: RS-485, half duplex
- Baud Rates: 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps.
- Protection: Withstand ANSI C37.90 fast transient, withstand 120V AC/DC applied to Data- and/or Data+.
- Fully isolated from Port C.

**PORT C**

- Standard: RS-485, half duplex
- Baud Rates: 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps.
- Protection: Withstand ANSI C37.90 fast transient, withstand 120V AC/DC applied to Data- and/or Data+.
- Fully isolated from Port A and Port B.

Figure 2.6.3.a     3720 MPCC Connector Configuration



**Terminal Block and LEDs**

The Multi-Port Communications Card (MPCC) provides a phoenix-style connector strip (see Figure 2.6.3). Terminal functions include:

SHLD	RS-485 shield for Port C (electrically connected to chassis ground)
-	RS-485 Data Minus for Port C
+	RS-485 Data Plus for Port C
SHLD	Port B (chassis ground)
CD / -	Carrier Detect or RS-485 Data Minus for Port B (see next section)
SG / +	Signal Ground for CD or RS-485 Data Minus for Port B (see next section)
SG	Standard RS-232 Signal Ground
TXD	RS-232 Transmit Data (data out)
RXD	RS-232 Receive Data (data in)
CTS	RS-232 Clear To Send (optional, see next section)
RTS	RS-232 Request To Send (optional, see next section)

Two LED indicators per port, TXD and RXD, show activity on the RS-485 or RS-232 communications lines and can be used to verify correct communications operation. The TXD indicator flashes when data is being sent out by the device. The RXD indicator flashes when data is being received by the device.

2.6.3.b     **MULTIPOINT COMMUNICATIONS CARD WITH ETHERNET (MPE)**

The optional MPE (Multiport Communications Card w/ Ethernet) allows the 3720 ACM to communicate via three distinct ports (one RS-232, one RS-485 and one Ethernet) within a multi-protocol environment. Each serial RS-232 or RS-485 port can be configured to operate with any of the supported protocols (PML, Modbus, AB DF-1, Alarm Dialer). All ports can communicate simultaneously. Optical coupling provides full isolation between the RS-232 / RS-485 ports, and the Ethernet port / metering equipment. In addition, protection circuitry on the RS-485 port provides a safeguard from common mode voltages that may be applied to the RS-485 port due to incorrect connection of the MPE.

Connections to the card are made by way of the eight pin “captured wire” connector and a standard RJ-45 UTP (unshielded twisted pair) jack, located on top of the card (see Figure 2.6.3.b).

**Communications Ports**

**PORT A**

- Standard: RS-232, half duplex
- Baud Rates: 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps.
- Signaling: Supports RTS (Request To Send) and CTS (Clear To Send) handshaking.
- Protection: Withstand ANSI C37.90.1 fast transient.
- Fully isolated from Port C.

**PORT B**

- Standard: RS-485, half duplex
- Baud Rates: 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps.
- Protection: Withstand ANSI C37.90.1 fast transient, withstand 120V AC/DC applied to Data- and/or Data+.
- Fully isolated from Port C.

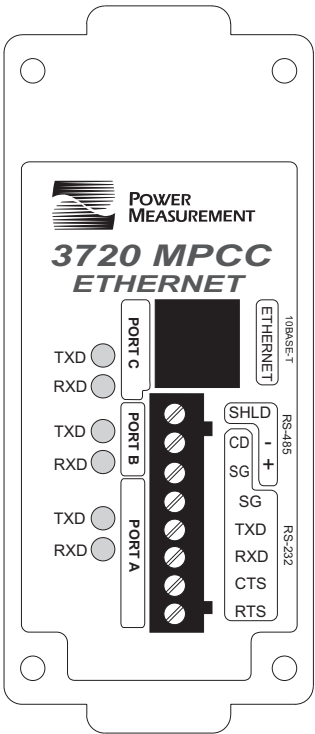
**PORT C**

- Standard: Ethernet, IEEE 802.3 (10Base-T)
- Baud Rate: 10 Megabits per second.
- Fully isolated from Port A and Port B.

**NOTE**

Certain timing considerations apply when using Power Measurement COM32 and COM128 RS232/RS485 converters with Allen Bradley DF-1 and Modicon Modbus protocols. Contact Customer Service for more information.

Figure 2.6.3.b     3720 MPE Connector Configuration



**Terminal block and leds**

The MPCC-Ethernet (MPE) provides a standard RJ-45 UTP jack and a phoenix style connector strip (see Figure 2.6.3.b). Terminal functions include:

ETHERNET	Ethernet jack for Port C
SHLD	RS-485 shield for Port B (electrically connected to chassis ground)
CD/-	Carrier Detect or RS-485 Data Minus for Port B (see next section)
SG/+	Signal Ground or RS-485 Data Plus for Port B (see next section)
SG	Standard RS-232 Signal Ground
TXD	RS-232 Transmit Data (data out)
RXD	RS-232 Receive Data (data in)
CTS	RS-232 Clear To Send (optional; see next section)
RTS	RS-232 Request To Send (optional; see next section)

Two LED indicators per port, TXD and RXD, show activity on the Ethernet, RS-485 or RS-232 communications lines and can be used to verify correct communications operation. The TXD indicator flashes when data is being sent out by the device. The RXD indicator flashes when data is being received by the device.

## RS-232 Connections

### TXD, RXD AND SG

These connections are identical to those used for the ISOCOM2 RS-232 port. Refer to Section 2.6.4.

### RTS AND CTS

The RTS line functions in an identical manner for the MPCC and MPE as for the ISOCOM2. Refer to Section 9.2.

#### NOTE

If CTS is not required, short the RTS and CTS lines together with a jumper wire between the two connectors.

### CARRIER DETECT

Carrier Detect is designed for applications where a modem is in use. To use Carrier Detect, a jumper wire must be connected between the Carrier Detect Signal Ground (SG) and the adjacent PORT A RS-232 standard Signal Ground (SG). See section 9.2 for more information.

#### NOTE

The use of the CD option will disable Port B for use as an RS-485 port.

## RS-485 Connections

Connections for each RS-485 port of the MPCC/MPE are identical to those used on the ISOCOM2. Refer to Section 2.6.5.

### Ethernet connection

The MPE connector consists of an RJ-45 jack. A UTP (unshielded twisted pair) 10Base-T cable connects the MPE to your local area network (LAN).

### COMMUNICATIONS PROTOCOL

The MPE communicates on an Ethernet network through TCP/IP. This protocol suite is an open standard and is used by the Internet.

### NETWORK PARAMETERS

Required network parameter for proper operation is a unique IP address for the device (3720 ACM). This IP address is typically assigned by a Network Administrator. Optional parameters include:

Network subnet mask (required if subnetting is applicable)

Default gateway address (required if cross-communication between networks is applicable)

## BASIC CONFIGURATION

### CAUTION !

To ensure proper integration with your existing LAN/WAN, it is highly recommended that your Network Administrator actively participates in configuring your MPE.

The IP address for the 3720 ACM must be set correctly **before** connecting the meter to the network. Failure to do so may result in network problems

Using the front panel switches of the 3720 ACM, scroll and select the following:

“Communications” menu

“Port C”

“Ethernet” protocol

Program the MPE's unique IP address (assigned by your Network Administrator) into the meter. The IP address consists of four blocks of numbers separated by periods. Enter each block of numbers in sequence.

For example, if the address is “192.168.2.150” (address shown here is for illustration purposes only; this address will not work on your network), you would enter this information as follows:

- IPAddr1 = 192
- IPAddr2 = 168
- IPAddr3 = 2
- IPAddr4 = 150.

The remaining configuration steps can be performed via Telnet, as described in the following section.

### TELNET CONFIGURATION

Using Telnet, connect to the IP address associated with the 3720 ACM. Log into the MPE as follows:

1. At the user name prompt, enter “pml”.
2. At the password prompt, enter your 3720 ACM meter password.

A menu containing available options can be displayed by typing “?”. To change the IP address, subnet mask or gateway address, type in the appropriate menu number and enter the information at the prompts.

Other configurable parameters are listed below (note that these only affect protocols being used on the Ethernet port):



- PML protocol password protect: Entering a value here specifies whether or not a password will be required to program the 3720 ACM, when it uses PML 3720 protocol over TCP/IP. This parameter can also be configured using the front panel buttons of the 3720 ACM.
- Modbus protocol password protect: Same as above, except for when it uses Modbus protocol over TCP/IP.
- Modbus register size: Select either 16 or 32 bit registers.
- Enabling or disabling possible additional Ethernet connections to the MPE: If either or both serial connections are set to "None", additional Ethernet connections can be made (a total of three connections can be made through the 10BaseT port). If required, these additional Ethernet connections may be explicitly disabled as well (disabling the additional Ethernet connections does not affect the use of the serial ports). Note that a Telnet connection cannot be locked out; if all three Ethernet connections are in use, one will be disrupted when a Telnet connection is initiated.

The MPE can also be completely configured via serial ports A or B. Contact Power Measurement for details.

#### SUPPORTED PROTOCOLS OVER TCP/IP

Currently, the MPE supports the PML and Modbus protocols.

#### FUTURE FIRMWARE UPGRADES

For ease of upgrading firmware, PML recommends that unused RS-232 or RS-485 ports be pre-wired, the reason being that upgrades are downloaded through the serial ports. Upgrading through the Ethernet port is not supported.

#### 2.6.4 RS-232 CONNECTIONS

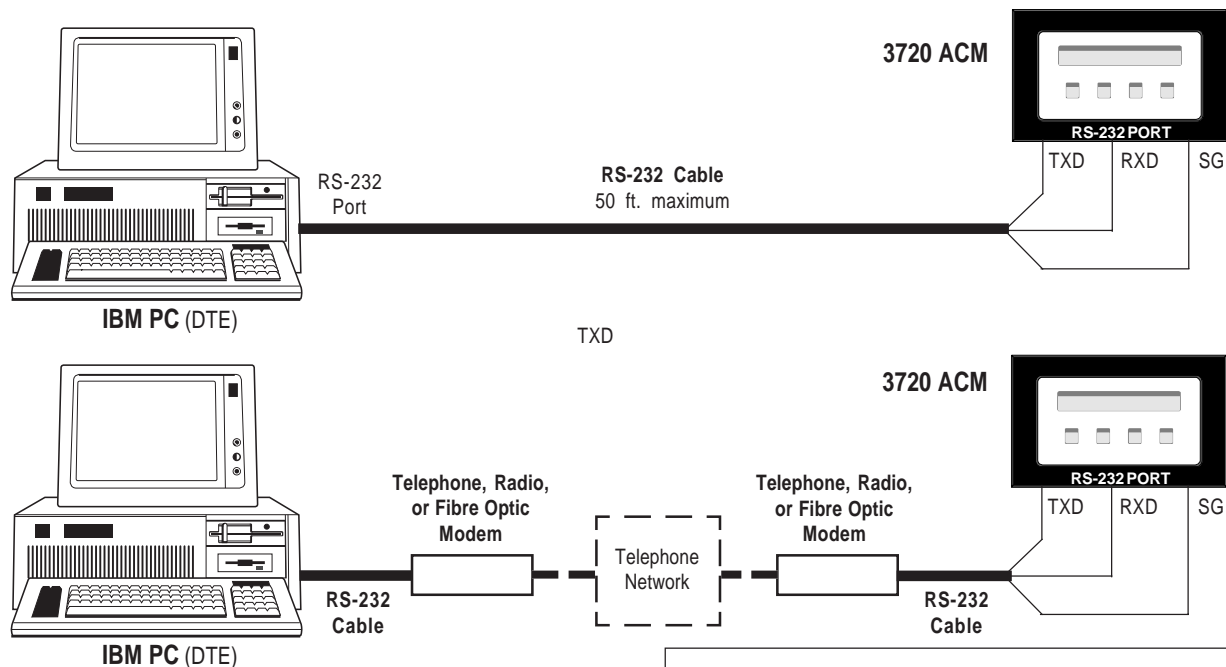
Figure 2.6.4a illustrates the wiring requirements for connection of the 3720 ACM using RS-232 communications. This can include a local direct connection to a computer or other device, or a remote connection via modem.

##### NOTE

For information on remote connections via modem (telephone, fibre optic, radio etc.) contact POWER MEASUREMENT Customer Service.

The RS-232 standard allows only a single point-to-point communications connection. Using this method, only one RS-232 equipped device may be connected to the serial port of the computer, modem, or other device.

Figure 2.6.4a RS-232 Communications Connections



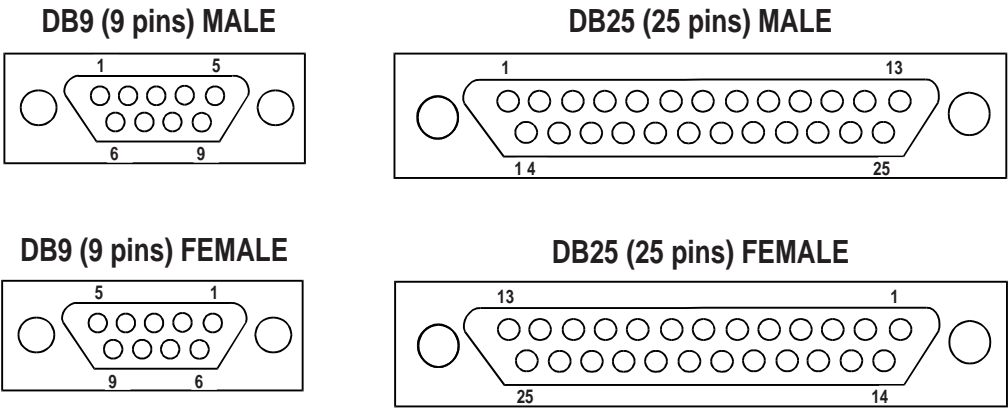
##### NOTE

1. See Figure 2.6.4b for RS-232 cable connections.
2. RTS, CTS, and CD connections are optional. See Section 2.6.3.



Figure 2.6.4b RS-232 Communication Cable Wiring

RS-232 CONNECTOR PINOUTS



RS-232 SERIAL CABLE WIRING CONNECTIONS

DTE				3720 ACM RS-232 Port
DB9	DB25	FUNCTION		FUNCTION
3	2	Transmit (TX)	→	Receive (RXD)
2	3	Receive (RX)	←	Transmit (TXD)
5	7	Signal Gnd (SG)	→	Signal Gnd (SG)
7	4	Request To Send (RTS)	→	Request To Send (RTS)
8	5	Clear To Send (CTS)	→	Clear To Send (CTS)
6	6	Data Set Ready (DSR)	→	Note: When using a MPCC, RTS and CTS lines <u>must</u> be jumpered.
4	20	Data Terminal Ready (DTR)	→	

Always jumper RTS to CTS at DTE end. →

Always jumper DSR to DTR at DTE end. →

DCE				3720 ACM RS-232 Port
DB9	DB25	FUNCTION		FUNCTION
2	3	Transmit (TX)	→	Receive (RXD)
3	2	Receive (RX)	←	Transmit (TXD)
5	7	Signal Gnd (SG)	→	Signal Gnd (SG)
7	4	Request To Send (RTS)	→	Request To Send (RTS)
8	5	Clear To Send (CTS)	→	Clear To Send (CTS)
6	6	Data Set Ready (DSR)	→	Note: Clear To Send (CTS) is only used with a MPCC.
4	20	Data Terminal Ready (DTR)	→	

Jumper RTS to CTS at DCE end if not used. →

Always jumper DSR to DTR at DCE end. →

Figure 2.6.4b illustrates all RS-232 cable configurations and wiring connections.

The cable used between a computer and modem (if used) is a standard straight-through RS-232 communications cable with a maximum length of 50 feet (15.2m). Refer to the installation manuals for both the computer and modem for cable requirements.

Typically, a computer is configured as a DTE device, whereas a modem is configured as a DCE device. Note that this is not always the case; refer to the computer and/or modem users manual for correct configuration.

The cables used between a DTE device and the 3720 ACM, or a DCE device and the 3720 ACM are each custom RS-232 cables. In each case, one end is equipped with a DB25 or DB9, male or female connector. The connector required depends on the mating connector of the computer or modem serial port. The other end of the cable consists of discrete wires which connect to the RS-232 terminals of the 3720 ACM. Cable length is 50 feet (15.2 m) maximum.

Refer to Chapter 9 for information regarding the use of the RTS line of the 3720 ACM.

### 2.6.5 RS-485 CONNECTIONS

RS-485 communications allows multiple devices to be connected on the same bus. Up to 32 devices can be connected on a single RS-485 bus, which consists of a shielded twisted pair cable. The overall length of the RS-485 cable connecting all devices cannot exceed 4000 ft. (1219 m).

To connect an RS-485 communications bus to a computer or other RS-232 equipped device, an RS-232 to RS-485 converter is required, such as POWER MEASUREMENT's COM32 or COM128. The COM32 offers a single RS-485 port, while the

COM128 offers a total of four RS-485 ports that can each support up to 32 devices.

#### General Bus Wiring Considerations

Devices connected on the bus, including the 3720 ACM, converter(s) and other instrumentation, must be wired as follows:

1. Use a good quality shielded twisted pair cable for each RS-485 bus. It is recommended that AWG 22 (0.6 mm) or larger conductor size be used.
2. Ensure that the polarity is correct when connecting to the RS-485 port (+) and (-) terminals of each device.
3. The shield of each segment of the RS-485 cable must be connected to ground at *one end only*.

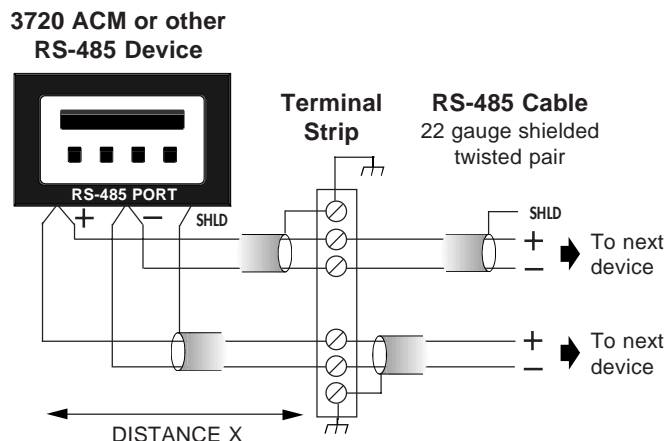
#### CAUTION

Do not connect ground to the shield at both ends of a segment. Doing so allows ground loop currents to flow in the shield, inducing noise in the communications cable.

4. It is recommended that an intermediate terminal strip be used to connect each device to the bus. This allows for easy removal of a device for servicing if necessary. Figure 2.6.5a illustrates the correct connections to a terminal strip. Do *not* use the T-connection illustrated. The end of Section 2.6.5 explains in more detail the connection methods to avoid.
5. Cables should be isolated as much as possible from sources of electrical noise.

Figure 2.6.5a RS-485 Intermediate Terminal Strip Connection

#### CORRECT CONNECTION METHOD



#### INCORRECT T-CONNECTION

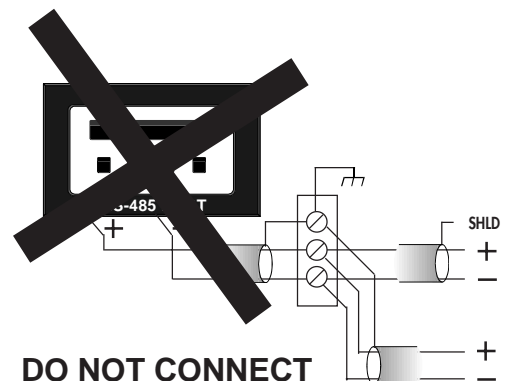
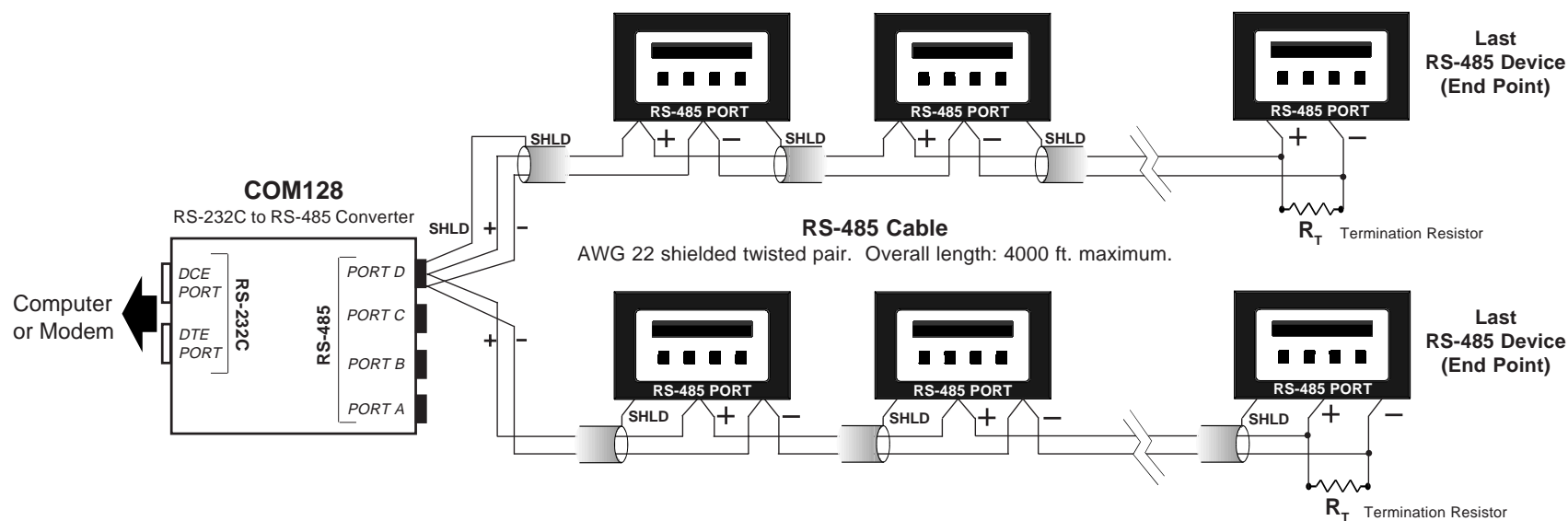
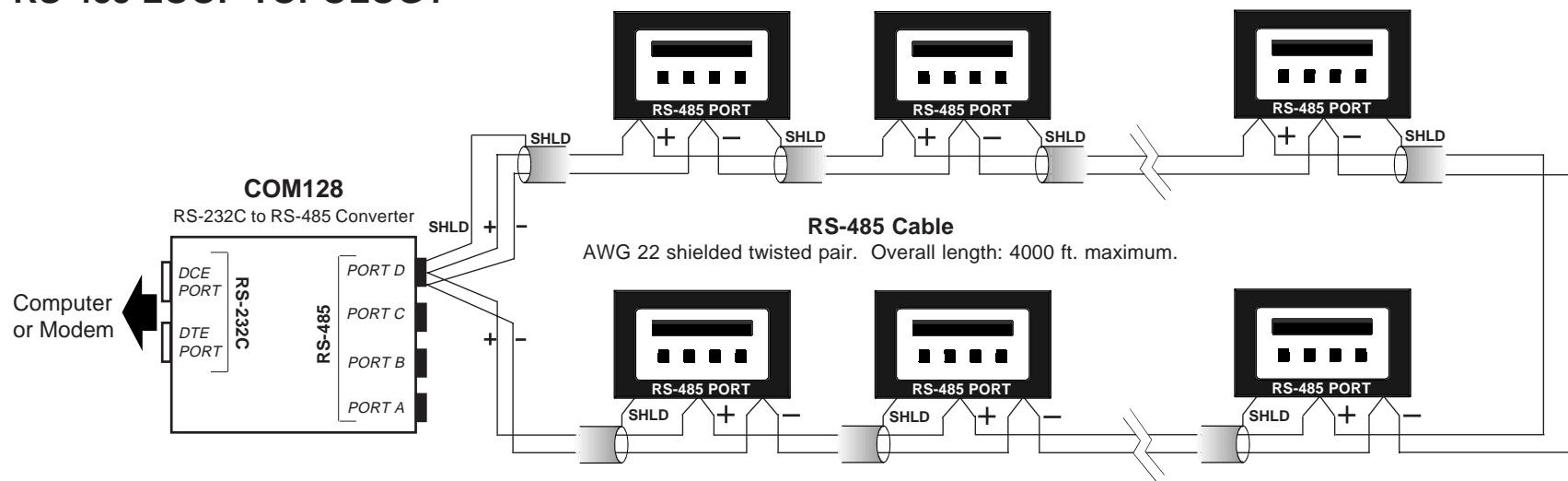


Figure 2.6.5b RS-485 Straight-Line and Loop Topologies

## RS-485 STRAIGHT-LINE TOPOLOGY



## RS-485 LOOP TOPOLOGY



## Recommended Topologies

Devices on an RS-485 bus are connected in a point-to-point configuration, with the (+) and (-) terminals of each device connected to the associated terminals on the next device. This is illustrated in Figure 2.6.5b.

While there are many topologies that can be used to connect devices on an RS-485 communication bus, the two recommended methods are the *straight-line* and *loop* topologies.

### STRAIGHT-LINE TOPOLOGY

The straight-line wiring method is illustrated in Figure 2.6.5b. Note that connections are shown for one RS-485 port only. The COM128 supports four RS-485 buses simultaneously. The COM128 can exist at any position on the RS-485 bus, including an end point.

Each end point of the straight-line bus must be terminated with a 1/4 watt resistor. These *termination resistors* reduce signal reflections which may corrupt data on the bus.

Termination resistors are connected between the (+) and (-) terminals of the device at each end of the bus. This device can include either a converter or any other instrument. The value of the resistor should match the line impedance of the cable being used. For AWG 22 shielded twisted pair cable, values between 150 and 300 ohms are typical. Consult the cable manufacturer's documentation for the exact impedance of your cable.

### LOOP TOPOLOGY

The loop wiring method is illustrated in Figure 2.6.5b. The COM128 can exist at any position on the RS-485 bus.

One advantage of the loop topology is that a single open circuit fault condition anywhere on the loop will not result in the loss of communication between the computer station and any of the remote devices.

The loop topology does not require termination resistors at any point on the bus.

## Calculating Overall Cable Length

When determining the overall length of an RS-485 communication straight-line or loop connection, it is important to account for all cable segments. For example, when RS-485 connections to the device are made via an intermediate terminal block (Figure 2.6.5a), the lengths of cable between the device and the terminal block must be added to the total cable distance. This length is equal to 2 times distance X in the diagram.

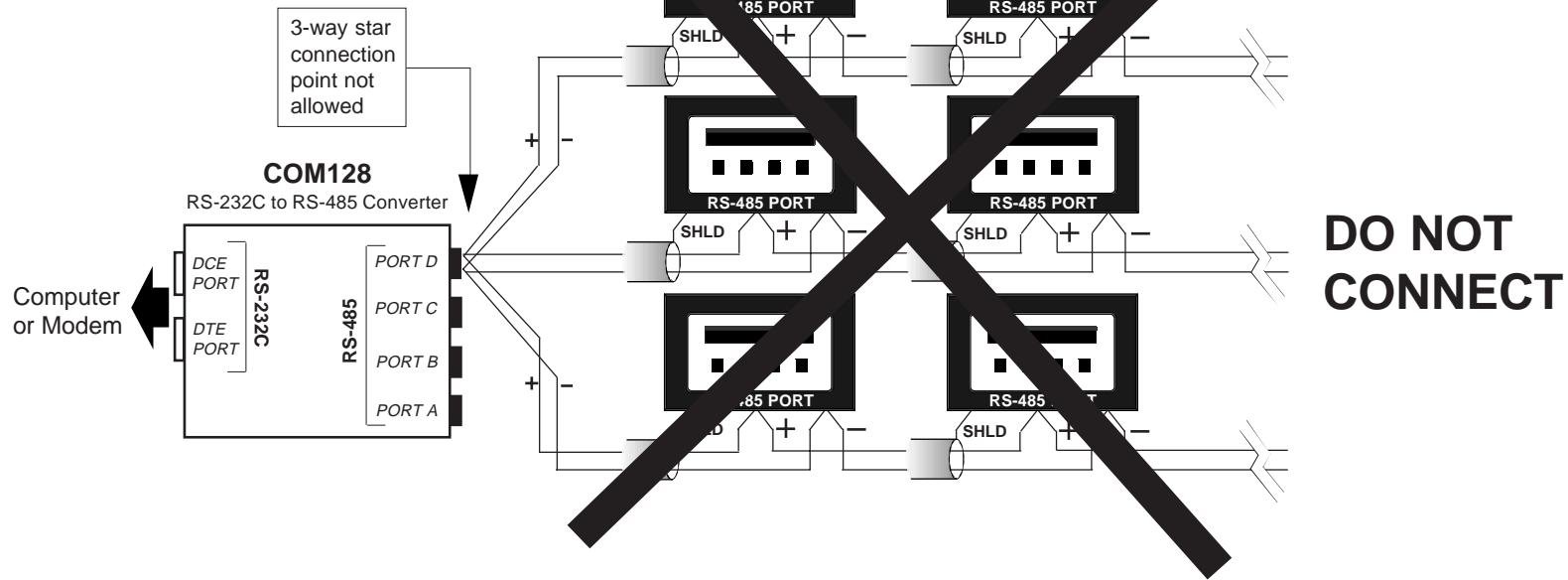
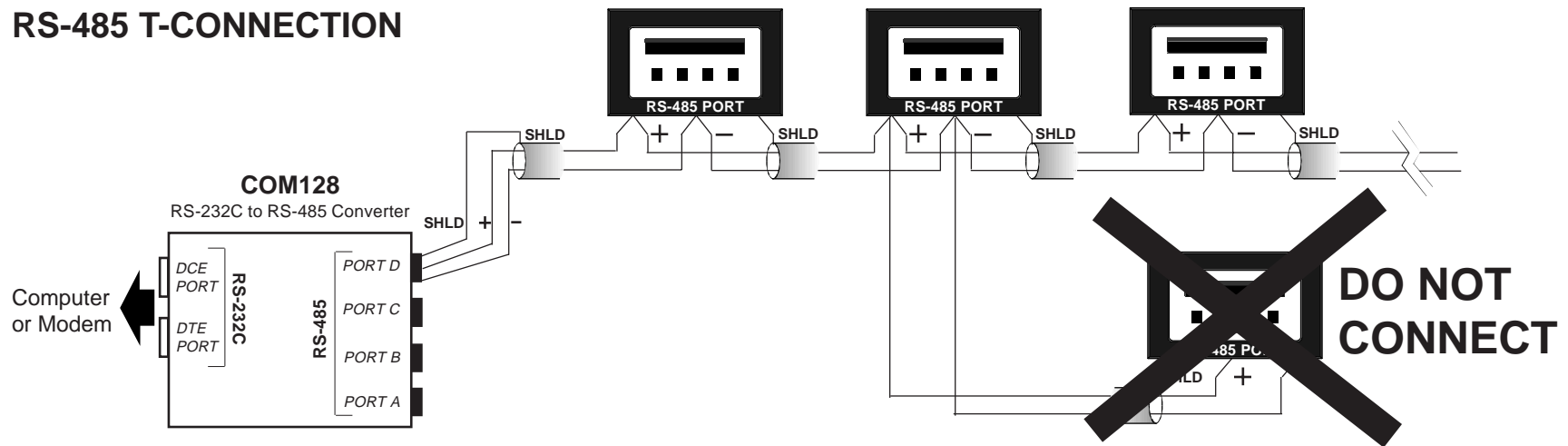
### Connection Methods to Avoid

Any device connection that causes a branch in the main RS-485 bus should be avoided. This includes *star* and *tee (T)* methods. Refer to Figure 2.6.5c for examples. These wiring methods cause signal reflections that may cause interference.

#### RULE OF THUMB

At any connection point on the RS-485 bus, no more than two (2) cables should be connected. This includes connection points on instruments, converters, and terminal strips. Following this guideline ensures that star and tee connections are avoided.

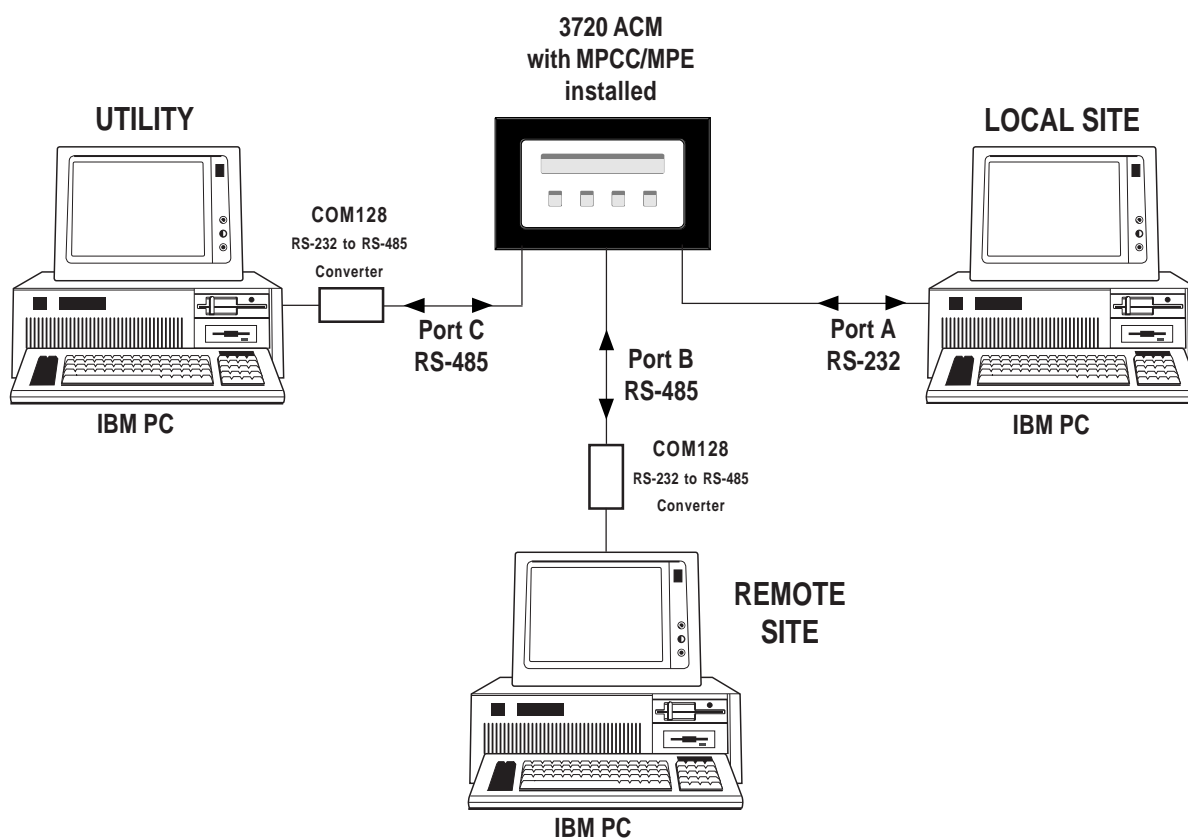
Figure 2.6.5c RS-485 Topologies to Avoid

**RS-485 STAR CONNECTION****RS-485 T-CONNECTION**

### 2.6.6 MULTIPOINT CONNECTIONS

With the use of the optional Multi-Port Communications Cards, the 3720 ACM is able to communicate simultaneously over three communications ports, in either PML, Modbus, AB DF-1, or Alarm Dialer protocols. This allows communications scenarios such as the sample application displayed in Figure 2.6.6.

Figure 2.6.6 MPCC Sample Application



## 2.7 CONTROL RELAY CONNECTIONS

This section describes the wiring connection requirements and applications of the 3720 ACM on-board control relays. Section 3.7 describes the operation of the relays.



# DANGER

### Primary Protection

The relays of the 3720 ACM should not be used for primary protection functions. These include applications where the device will be providing:

- a) Overcurrent protection on circuit breakers (I<sup>2</sup>t applications).
- b) Protection of people from injury. If failure of the device can cause injury or death, the 3720 ACM should not be used.
- c) Energy limiting. If failure of the device will cause sufficient energy to be released that a fire is likely, the 3720 ACM should not be used. In electrical systems, energy limiting is normally provided by circuit breakers or fuses.

### Secondary Protection

The 3720 ACM can be used for secondary protection functions. Secondary protection includes:

Situations where the 3720 ACM is backing up a primary protection device (shadow protection), such as an overcurrent relay.

Situations where the 3720 ACM is protecting equipment, not people. This typically includes applications such as over/under voltage, voltage unbalance, over/under frequency, reverse power flow, or phase reversal protection, etc.

2.7.1 RELAY APPLICATION PRECAUTIONS

CAUTION

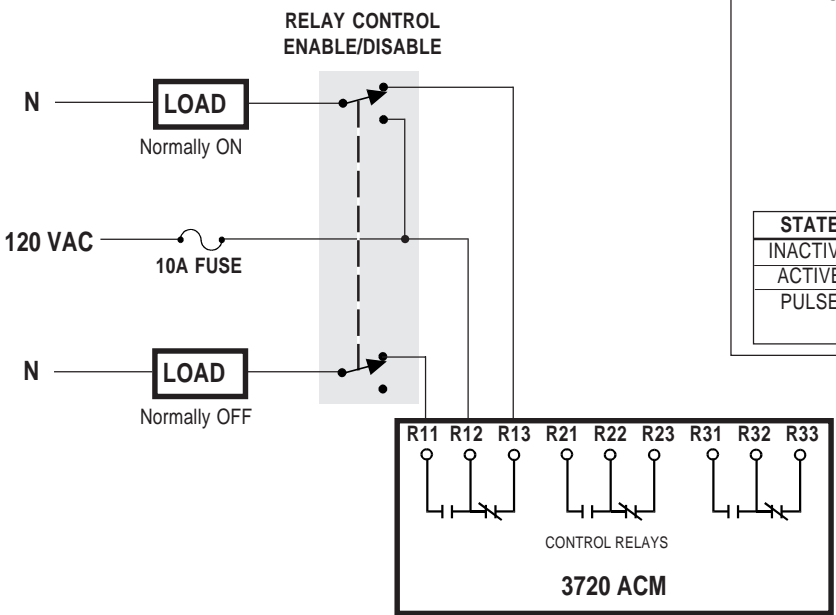
In applications where the relays are used to perform critical equipment control operations (i.e. breaker trip, etc.), the important precautions described below should be followed.

1. Connection to the external equipment should be made via an intermediate mechanism which allows relay control to be completely disabled for commissioning and servicing (see Figure 2.7.2).
2. Following initial power up, the 3720 ACM should be programmed (see Chapter 3), including all required setpoints for setpoint controlled relay operations (see Chapter 5).
3. The relay outputs of the 3720 ACM should be tested to ensure that setpoint or manual control condition(s) are occurring as expected.
4. Once correct relay operation has been verified, relay control of the external equipment can be enabled.

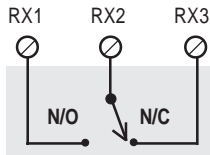
2.7.2 FORM-C RELAYS

The basic 3720 ACM provides 3 Form-C electromechanical control relays. These relays are rated for 277 VAC or 30 VDC at 10 Amps resistive load. Figure 2.7.2 illustrates the required connections.

Figure 2.7.2 Form-C Control Relay Connections



OPERATIONAL BLOCK DIAGRAM FOR ALL RELAYS



STATE	RX1/RX2	RX2/RX3
INACTIVE	Open	Closed
ACTIVE	Closed	Open
PULSE	Closed for duration of pulse	Open for duration of pulse

NOTES

1. Relays are Form C dry contact rated at 277 VAC or 30 VDC @ 10 Amps.
2. Only relevant 3720 ACM terminal block connection points are illustrated.



2.7.3 SOLID STATE RELAYS

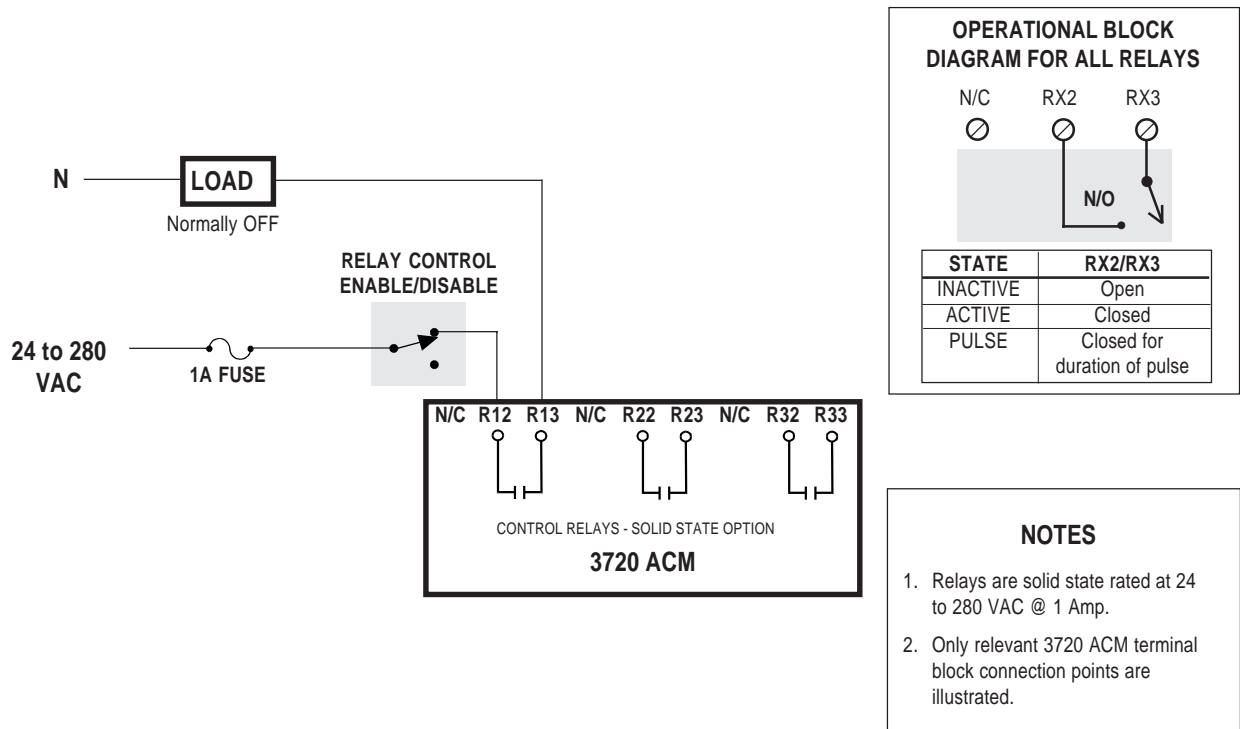
The SSR option of the 3720 ACM provides three single-pole, single throw (SPST) solid state relays. These relays are rated for 24 to 280 VAC operation at 1 Amp AC resistive maximum. The relays offer significantly longer lifetimes than electromechanical relays when used for continuous pulsing applications.

Relay terminals RX2 and RX3 are used for each relay (where X = 1, 2, or 3). The RX1 terminal for each relay is left unused (no connection). See Figure 2.7.3.

**IMPORTANT NOTE**

**USE AC VOLTAGES ONLY.**  
The relays are solid state and use zero-crossing turn on and off. This requires that they use AC voltages only.

Figure 2.7.3 Solid State Relay Option Connections



## 2.8 STATUS INPUT CONNECTIONS

This section illustrates wiring connection methods and applications for the status inputs. Chapter 3, Section 3.8 describes the operation of the status inputs.

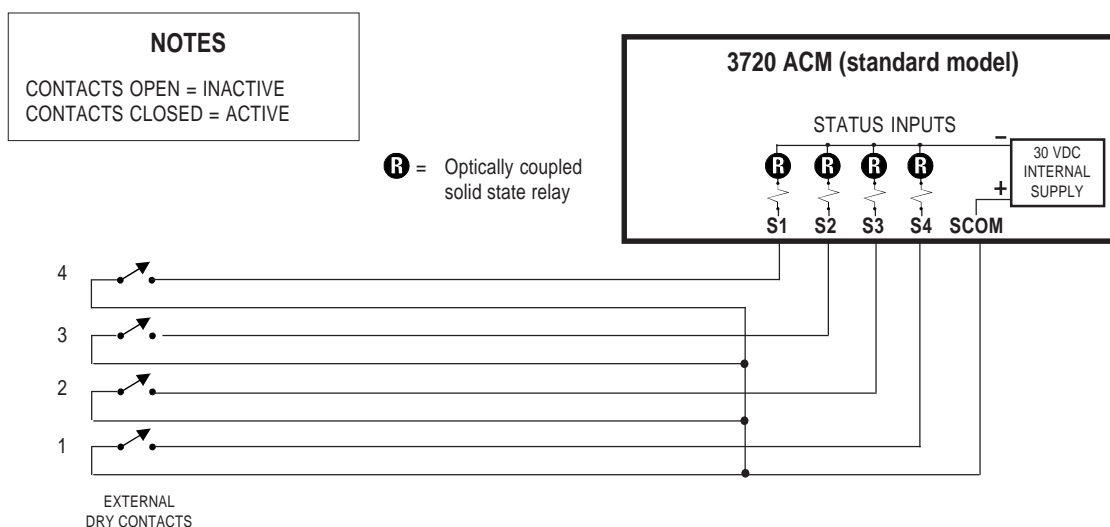
The 3720 ACM uses a current sensing technique to monitor the status of an external dry contact. The 3720 ACM provides an internal 30 VDC supply for *self-excitation* of the status inputs (see Figure 2.8.1). These can be used for dry contact sensing applications, but *not* for voltage sensing applications. Note that no ground or external voltage connections are required.

### CAUTION

The 3720 ACM status inputs can only be used for dry contact sensing applications. Connection of an external voltage source to the any of the status inputs of a standard equipped 3720 ACM can cause permanent damage to the 3720 ACM.

An open contact registers as INACTIVE; a closed contact registers as ACTIVE.

Figure 2.8.1 Status Input Connections for Dry Contact Sensing - Self Excitation



2.9 AUXILIARY VOLTAGE INPUT CONNECTIONS

Figure 2.9.1 illustrates a number of possible wiring connection methods and applications for the VAUX input. Section 3.9 describes the operation of this input.

CAUTION

VAUX is a non-isolated input. If full isolation is required, use an intermediate isolation transducer.

Figure 2.9.1 Auxiliary Voltage Input Connections

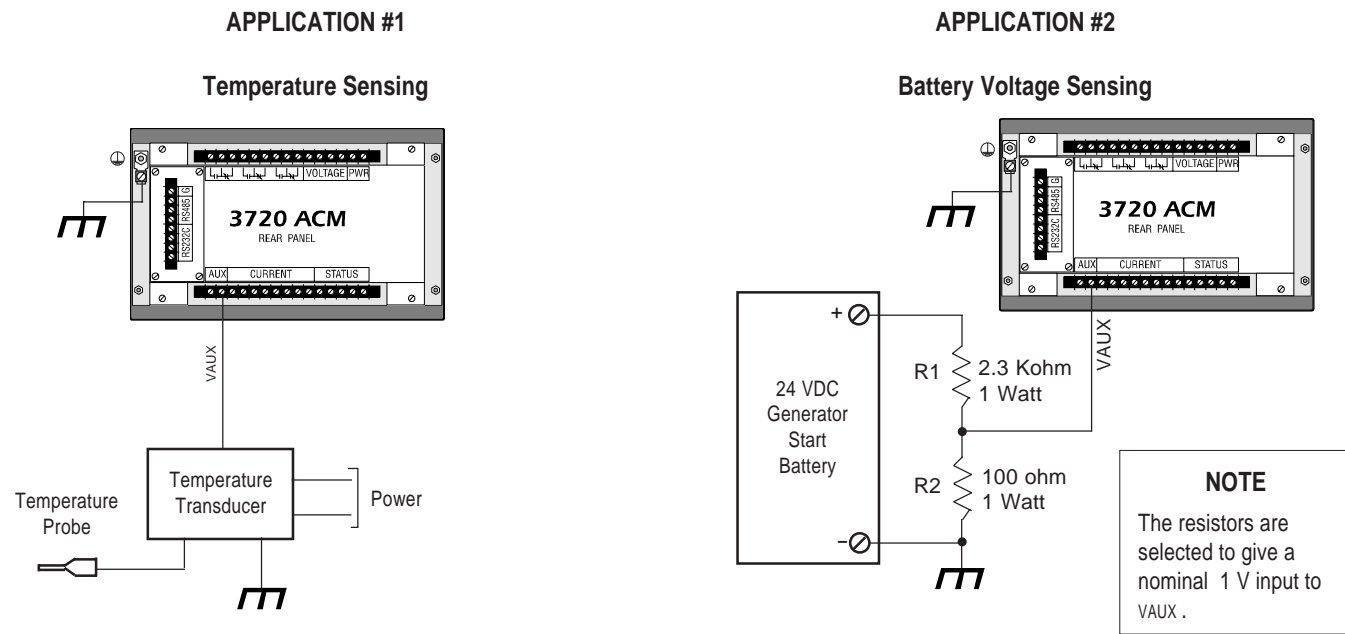
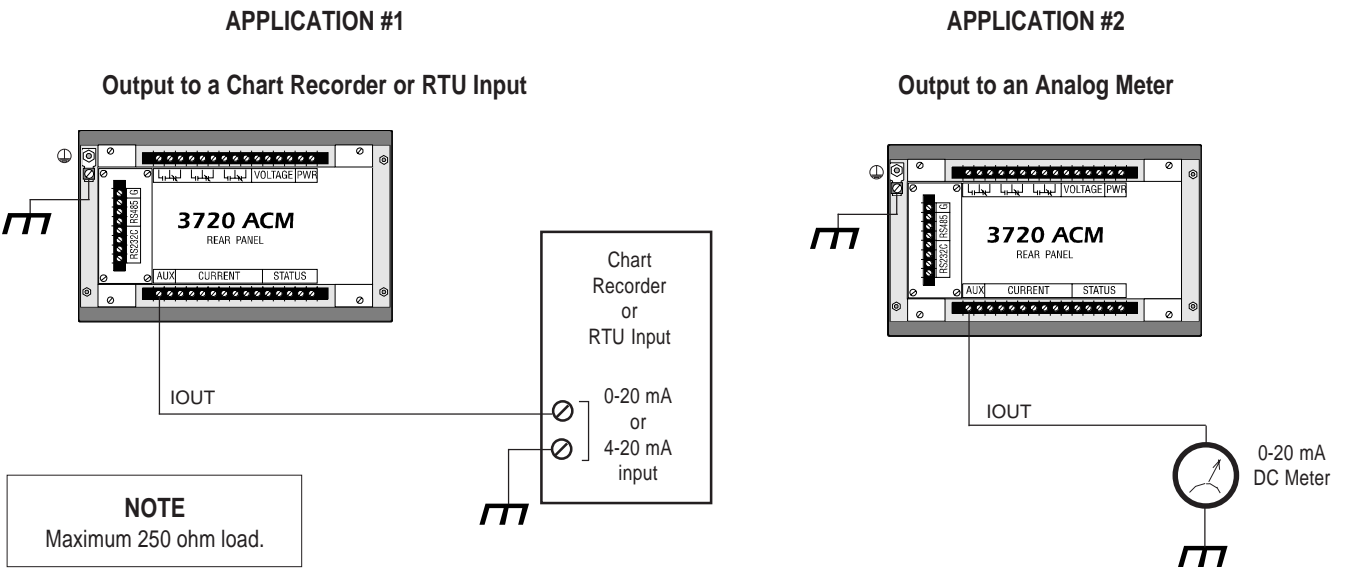


Figure 2.10.1 Auxiliary Current Output Connections



## 2.10 AUXILIARY CURRENT OUTPUT CONNECTIONS

Figure 2.10.1 illustrates a number of possible wiring connection methods and applications for the IOUT output. Section 3.10 describes the operation of this output.

### CAUTION

IOUT is a non-isolated input. If full isolation is required, use an intermediate isolation transducer.

## 2.11 MAINTENANCE

The following two circumstances describe the only regular maintenance that the 3720 ACM may require.

### 2.11.1 BATTERY REPLACEMENT

The 3720 ACM non-volatile memory (NVRAM) and real-time clock (RTC) circuit contain integrated battery backup systems.

#### NVRAM

The rated life of the NVRAM battery is seventy years at 50°C (122°F), 28 years at 60°C (140°F), and 11 years at 70°C (158°F). If the unit operates at less than 50°C for 60% of the time, less than 60°C for 90% of the time, and less than 70°C for 100% of the time, the expected life of the NVRAM battery is 35 years. If the meter is operating in an environment where the temperatures regularly exceed 60°C, the NVRAM should be replaced every ten years.

#### REAL-TIME CLOCK

The battery system for the RTC may exhibit a somewhat shorter lifespan than the NVRAM backup, due to the fact that it remains active (i.e. the clock continues to run) when the meter is unpowered.

#### BATTERY CHECK

The present condition of the NVRAM and real-time clock batteries can be checked from the front panel of the 3720 ACM by viewing the *extended diagnostics* parameters. See Section 4.6 for instructions. If remaining battery life is 10% or less, the NVRAM should be replaced.

Contact POWER MEASUREMENT or your local representative for information on replacement procedures.

### NOTE

When the NVRAM is replaced, historic data may be lost. We recommend backing up critical logged data to the hard drive of a computer prior to servicing. Setup parameters and calibration of the unit are not affected.

### 2.11.2 DISPLAY RESTORE



The 3720 ACM front panel display is a vacuum-fluorescent type which exhibits high visibility due to its exceptional brightness. Due to a natural buildup of internal residues, the brightness of individual segments may become degraded over extended periods when the display is not in use (i.e. when the DISPLAY TIMEOUT feature is used).

The brightness and consistency of all display segments can be simply restored as follows:



1. Enter programming mode and set the DISPLAY RESTORE parameter (under DISPLAY) to YES.
2. Return to display mode. All segments of all characters in the display are lit.
3. Leave the display in this mode for an extended period of time. 24 to 48 hours is recommended.
4. Press any button on the front panel to return to normal display mode.

## 2.12 FIELD SERVICE CONSIDERATIONS

In the unlikely event that the 3720 ACM unit should fail, servicing requires disconnection and removal of the unit from its mounting for the purpose of repair, or for exchange with a replacement unit. The initial installation should be done in a way which makes this as convenient as possible:

	 <b>DANGER</b>
	PT secondary circuits are capable of generating lethal voltages and currents with their primary circuit energized. Standard safety precautions should be followed while performing any installation or service on the device (i.e. removing PT fuses, etc.)

1. All phase voltage sense leads should be protected by breakers or fuses at their source such that the 3720 ACM can be safely disconnected.
2. A CT shorting block should be provided so that the 3720 ACM current inputs can be safely disconnected without open circuiting the CT's. The shorting block should be wired so that protective relaying is not affected.

	 <b>DANGER</b>
	CT secondary circuits are capable of generating lethal voltages and currents when open circuited with their primary circuit energized. Standard safety precautions should be followed while performing any installation or service on the device (i.e. shorting CT secondaries, etc.)

3. All wiring should be routed to allow easy removal of the connections to the 3720 ACM terminal strips, the 3720 ACM rear cover, and the 3720 ACM itself.
4. If the control relays are used, there should be a bypass mechanism installed (see Section 2.7).

Refer all questions regarding proper working procedures to qualified personnel.

## 3 GENERAL OPERATION

### 3.1 INTRODUCTION

This chapter describes the following:

- Power up procedure.
- Front panel operation, included instructions for displaying real-time data and for performing field programming.
- Basic device setup procedure.
- Basic hardware operation, including descriptions of the relays, status inputs, and auxiliary input and output.

For a complete and detailed list of all measured parameters (not including TOU) and status information provided by the 3720 ACM, refer to Chapter 4.

Chapter 5 describes the Time-Of-Use (TOU) system.

Chapters 6 to 8 describe the setup and operation of the advanced features of the 3720 ACM, including setpoint, waveform and logging functions.

Remote communications setup and operation are described in Chapter 9.

#### NOTE

The TRAN model provides no front panel display or keypad. Data is read, and field programming performed, via the device's communications port. Refer to Chapter 8 for instructions regarding TRAN operation. For the TRAN model, disregard all references made to front panel operations in Chapter 3.

### 3.2 POWER UP

After all installation wiring is complete and has been double checked, the unit may be powered up by applying the appropriate voltage to the POWER input terminals.

The 3720 ACM first enters its *display mode*, presenting Volts-Phase-Amps-Power Function. The power function displayed on power-up is kW average, totalled for all phases.

The values initially appearing may not be correct, since the unit has not yet been told a number of necessary pieces of information about the installation. The process of giving the 3720 ACM this information is known as *field programming*.

The 3720 ACM display mode and field programming mode are each described in detail in the following sections.

## 3.3 DISPLAY MODE

### 3.3.1 FRONT PANEL DISPLAY

#### Data Display and Formats

The 3720 ACM provides a unique and very flexible user interface. The front panel features a large, high-visibility, 20-character vacuum fluorescent display. The display can present a wide variety of information in many different formats. The user can also customize the display by defining which measured parameters can be accessed and in what format they are displayed. The following information and formats can be displayed:

#### BASIC PHASE DISPLAY

The basic front panel display (on power-up) presents VOLTS, AMPS and POWER FUNCTIONS for the selected PHASE (f) (Figure 3.3.1a). The PHASE button is used to advance through each phase in sequence, while a selection of power functions can be accessed using the FUNCTION button. The format of the phase labels and numeric readings can be programmed to conform to world conventions (see Section 3.6).

#### FULL WIDTH DISPLAYS

Very large measured values (i.e. kW Hours) and parameters with large display labels are presented using the entire display (Figure 3.3.1b).

#### NOTE

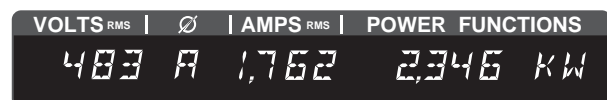
While viewing a full-width display, press the PHASE button to return to the standard Volts-Phase-Amps display.

#### 3-PHASE DISPLAYS

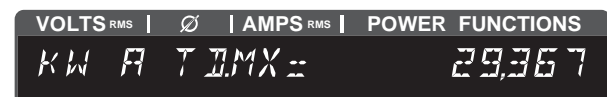
Concurrent display of readings for all three voltage or current phases is possible (Figure 3.3.1c). The GROUP buttons can be programmed to access these displays (see Section 3.3.2).

#### STATUS INFORMATION

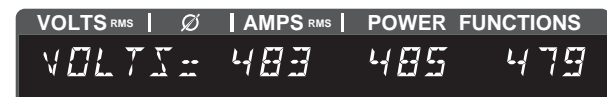
Status information includes the present condition of the three relays, four digital (status) inputs, and seventeen setpoints. The GROUP buttons can be programmed to access all status information (see Section 3.2.2). Display labels for relay and status input conditions are user definable via communications (Figures 3.3.1d and e). For example, the two possible conditions of a setpoint-controlled relay could be displayed as "BREAKER NORMAL" and "OVER CURRENT TRIP". Device programming is described in Section 3.4

**Figure 3.3.1** Front Panel Display Examples

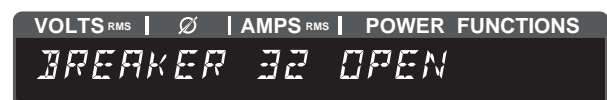
a) Standard Phase Display



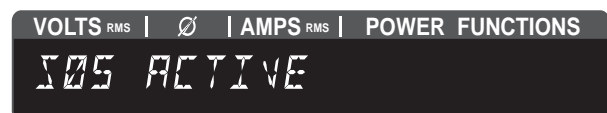
b) Full Width Displays (ex. kW, phase A, therm. demand, max.)



c) 3 Phase Displays



d) Status Information (Example: Status Input Condition)



e) Status Information (Example: Setpoint Condition)

*Note: Display labels for relay and status input information (example [d] above) are user definable.*

<b>RT</b>	<b>Real Time</b>
<b>THD</b>	<b>Total Harmonic Distortion</b>
<b>TEH</b>	<b>Total Even Harmonic Distortion</b>
<b>TOH</b>	<b>Total Odd Harmonic Distortion</b>
<b>HD1</b>	<b>Individual Harmonic Distortion (example is HD15)</b>
<b>TD</b>	<b>Thermal Demand</b>
<b>SD</b>	<b>Sliding Window Demand</b>
<b>PD</b>	<b>Predicted S.W. Demand</b>
<b>MN</b>	<b>Minimum</b>
<b>MX</b>	<b>Maximum</b>
<b>IM</b>	<b>Imported (energy)</b>
<b>EX</b>	<b>Exported (energy)</b>
<b>NT</b>	<b>Net (difference between imported and exported)</b>
<b>TOT</b>	<b>Total (total of imported and exported)</b>
<b>R3</b>	<b>Relay Output (example is R3)</b>
<b>S4</b>	<b>Status Input (example is S4)</b>
<b>HS6</b>	<b>High-Speed Setpoint (example is HS6)</b>
<b>SP1</b>	<b>Standard Setpoint (example is SP11)</b>
<b>TOU</b>	<b>Time-Of-Use (registers, tariffs, etc.)</b>
<b>TOC</b>	<b>Time-Overcurrent Curve</b>
<b>HSS</b>	<b>High-Speed Snapshot Log</b>

f) Display Labels for Measured Parameter Modes &amp; Status Information

## Display Labels

The wide range of measured parameters and status information provided by the 3720 ACM requires that special parameter name formats be used on the front panel. These labels are also used to identify parameter types selected by the user in programming mode.

Figure 3.3.1f lists the display labels used by the 3720 ACM to identify various measurement modes and status information. These labels are further described in Chapter 4.

## Display Resolution

The 3720 ACM front panel can display readings with up to 9 digits of resolution. Decimal resolutions depend on the parameter being displayed.

- Most measured parameter readings are displayed in integer format, using no decimal places.
- Harmonic Distortion readings are displayed with one decimal place of resolution.
- Frequency readings are displayed with two decimal places of resolution.

- Status Input Counter totals can be displayed with between 0 and 3 decimal places of resolution dependent on the user-definable RESOLUTION parameter (see Section 3.8).

## Display Timeout

The life and brightness of the 3720 ACM vacuum fluorescent display can be significantly extended by reducing the on time. The 3720 ACM provides a DISPLAY TIMEOUT parameter that can be used to set a timeout interval of 1 to 999 minutes, after which the display automatically switches to *display-saver mode* ("PML" scrolling across the display). This interval starts counting down from the last button press made on the front panel. A timeout interval of 180 minutes (3 hours) or less is recommended. Setting the parameter to zero causes the display to stay on indefinitely. While the display is turned off, pressing any button on the front panel turns it back on again. Device programming is described in Section 3.4.



3.3.2 FRONT PANEL BUTTONS

The 3720 ACM uses four long-life, stainless steel membrane switches for parameter selection and programming functions. (See figure 3.3.2)

Phase Button

If you are viewing the standard display, the PHASE button advances through each phase. The sequence of phase readings depends on the device setup, including the VOLTS MODE and PHASE ROTATION selected. Device setup is described in Section 3.4 The phase field of the front panel display indicates the phase for which readings are being displayed.

The following phase labels are used:

A B C

These labels indicate line-to-neutral values are being displayed for the indicated phase.

A, B, C,

Phase indicators displayed with a comma indicate line-to-line values are being displayed for the indicated phase.

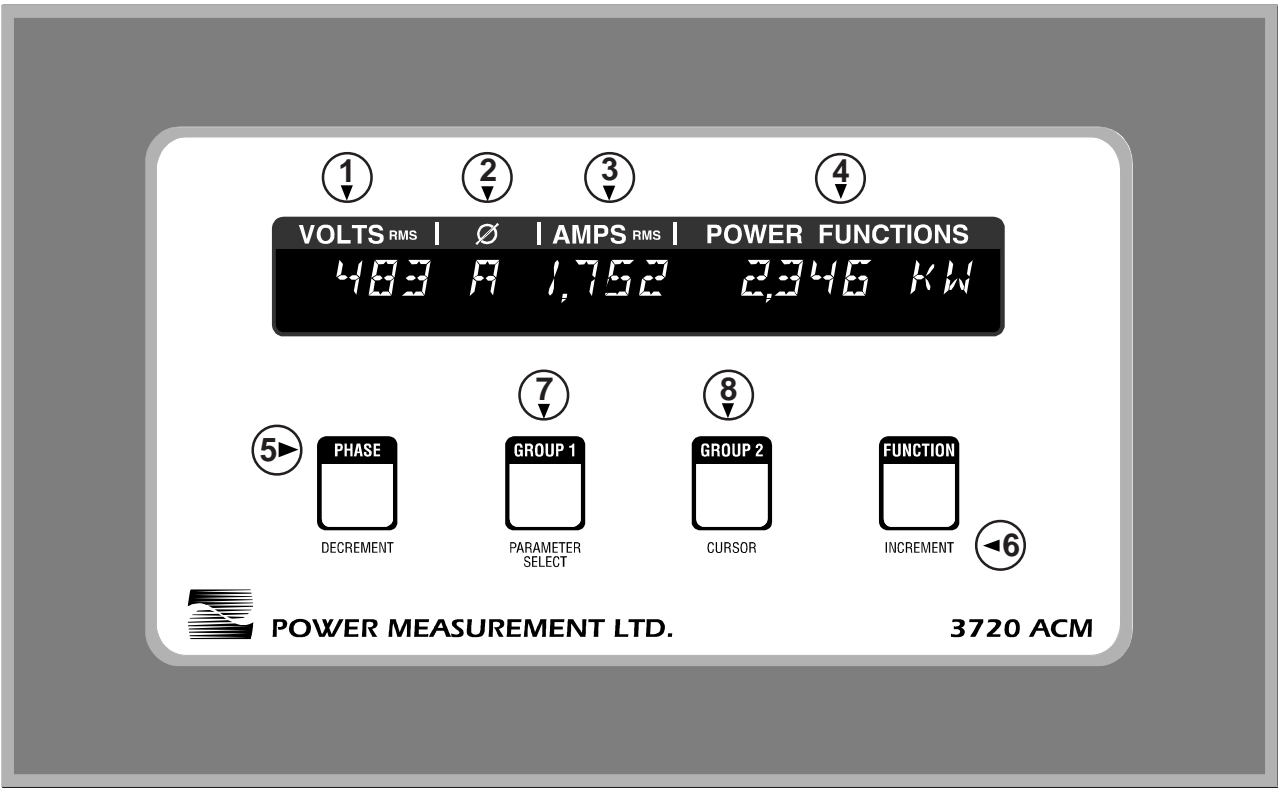
\* \*

An asterisk symbol indicates that the average for all line-to-neutral or line-to-line phases is being displayed.

”

A quotation mark after a value (measurement) indicates a CT/PT secondary measurement.

Figure 3.3.2 3720 ACM Front Panel Features



- |                          |   |
|--------------------------|---|
| 1. 4-digit VOLTS display | 4. 5-digit / 8-character POWER FUNCTION display             |
| 2. PHASE indicator       | 5. Top button labels indicate display mode functions        |
| 3. 4-digit AMPS display  | 6. Bottom button labels indicate programming mode functions |

7 & 8    GROUP1 + GROUP2 together = enter programming mode or return to display mode

The following phases of readings are available in each mode:

**VOLTS MODE = 4W-WYE, 3W-WYE, OR DEMO.**

For each of these modes, the **PHASE** button advances through:

- line-to-neutral average of the three phases
- line-to-neutral values for each phase
- line-to-line average of the three phases
- line-to-line values for each phase

**VOLTS MODE = DELTA**

The **PHASE** button advances through:

- line-to-line average of the three phases
- line-to-line values for each phase

**VOLTS MODE = SINGLE**

The **PHASE** button advances through:

- line-to-neutral average of the two phases
- line-to-neutral values for each phase and the line-to-line value

The **PHASE** button also advances the display through each relay (R1 to R3), digital status input (S1 to S4), or setpoint (S01 to S11, H01 to H06) when status conditions are being displayed.

### Auto Phase Cycling Mode

You can make the 3720 ACM automatically cycle the display through each phase by holding down the **PHASE** button for more than 4 seconds, then releasing. The display advances through each phase (A, B etc.) at 4 second intervals, displaying the volts and amps for each phase. Pressing any button returns the display to the regular non-cycling viewing mode.

### Function Button

A preset list of useful power function parameters is available via the **FUNCTION** button. Press the **FUNCTION** button to advance through each measured parameter.

For per phase values displayed using the **FUNCTION** button, the **PHASE** button can be used to advance the display through each phase.

The following is the complete sequence of power function parameters accessible using the **FUNCTION** button:

- kW per phase
- kVAR per phase
- kVA per phase
- Power Factor per phase
- Current I4
- Frequency (phase A)
- Voltage Vaux
- kWH Import (total for all 3 phases)
- kWH Export (total for all 3 phases)
- kVARH Import (total for all 3 phases)
- kVARH Export (total for all 3 phases)
- kVAH Net (total for all 3 phases)

A full description of each parameter is provided in Chapter 4.

### Auto Function Cycling Mode

You can make the 3720 ACM automatically cycle the display through each power function on the front panel display. The power functions displayed are the group of parameters normally displayed using the **FUNCTION** button (kW, kVAR, etc.) To start the cycling mode, hold down the **FUNCTION** button for more than 4 seconds, then release. The display will advance through each power function at 4 second intervals. Pressing any button will return the display to the regular non-cycling viewing mode.

### Group Buttons

You can use the **GROUP1** and **GROUP2** buttons to display additional groups of measurements and status information. The parameters accessible using each **GROUP** button are user-definable. Up to 18 parameters may be assigned to each button. Similar to the **FUNCTION** button, each press of a **GROUP** button will advance the display through the list of items assigned to that button.

The **GROUP** buttons are ideal for creating convenient custom groupings of important parameters for quick viewing. For example, the user might wish to assign the third and fifth harmonic distortion values for each input to the **GROUP1** button and relay status information to the **GROUP2** button. Any of the measured and status parameters can be assigned to either **GROUP** button. Programming the **GROUP** buttons must be performed via communications.

For per phase parameters displayed using the **GROUP** buttons, the **PHASE** button can be used to advance the display through each phase. For relay, status input, and setpoint conditions, the **PHASE** button can be used to advance through each relay, status input or setpoint number. The **MODE** function can also be used to display additional related parameters, if applicable. This is described later in this section.

The following default parameters have been assigned to each **GROUP** button.

**GROUP 1:**

- 3-phase Voltage line-to-neutral (if applicable)
- 3-phase Voltage line-to-line
- 3-phase Current
- Voltage line-to-neutral Maximum per phase (if applicable)
- Voltage line-to-line Maximum per phase
- Current Maximum per phase
- kW Maximum per phase
- kVAR Maximum per phase
- Frequency Maximum (phase A)
- Power Factor Minimum per phase
- Power Factor Maximum per phase
- Frequency Minimum (phase A)
- Voltage line-to-neutral Minimum per phase
- Voltage line-to-line Minimum per phase
- Relay Condition (1 to 3)
- Status Input Condition (1 to 4)

**GROUP 2:**

- Voltage THD (total harmonic distortion) per phase
- Current THD per phase
- Voltage THD Maximum per phase
- Current THD Maximum per phase
- Current 3rd HD (harmonic distortion) per phase
- Current 5th HD per phase
- Current 7th HD per phase
- Current Sliding Window Demand Maximum average of all phases
- kW Sliding Window Demand Maximum total of all phases
- kVAR Sliding Window Demand Maximum total of all phases
- kVA Sliding Window Demand Maximum total of all phases

A full description of each parameter is provided in Chapter 4.

## Mode Function

As an added convenience feature, a special **MODE** function has been provided for use with parameters assigned to the **GROUP1** or **GROUP2** button.

The **MODE** function provides quick access to additional measurement modes for the parameter currently being displayed, if applicable. For power and harmonic distortion parameters, this can include demand and minima/maxima. For example, if the front panel display is presenting a kW measurement, the **MODE** function can be used to advance the display through kW Min, kW Max, kW Thermal Demand, kW Thermal Demand Min, and kW Thermal Demand Max. The sequence of parameters displayed is definable by the user via communications.

The **MODE** function can also be used to advance through all bi-directional modes of an energy parameter. This can include import, export, net, and total measurements.

The **MODE** function is accessed using a special button combination on the front panel:

1. First, press either **GROUP** button to display the desired parameter.
2. Press and hold down either **GROUP** button.
3. With the **GROUP** button held down, press the **FUNCTION** button.
4. Release the **FUNCTION** button.
5. With the **GROUP** button still held down, pressing the **FUNCTION** button will advance through each available mode.
6. To return the front panel buttons back to normal operation, first release the **GROUP** button, then press the **FUNCTION** button once more.

### NOTE

If a particular parameter accessed using a **GROUP** button has not been programmed to provide additional modes, the **MODE** function has no effect.

## 3.4 FIELD PROGRAMMING

### 3.4.1 INTRODUCTION

Basic device programming can be performed quickly and easily from the front panel, or via the communications port using a portable or remotely located computer. Basic setup parameters include scaling factors for the voltage and current inputs, voltage mode (wye, delta, etc.), and communications settings.

Advanced features including waveform capture, waveform recording, data logging, setpoint and relay control functions, and customization of the front panel display and GROUP buttons are programmable via the communications port only. POWER MEASUREMENT's PC-based SCADA software fully supports 3720 ACM programming, providing a number of parameter screens which make setup quick and easy. The open communications protocol of the 3720 ACM also allows free access to all programming parameters using any compatible third-party system.

Setup and other critical information are saved when power is turned off. All programming is password protected.

A complete list of all programmable setup parameters is provided in Section 3.4.6.

This manual describes procedures for programming the 3720 ACM from its front panel only. For information on programming via communications using the SCADA software, refer to the *SCADA Software Installation and Operation Manual*.

### 3.4.2 ENTERING PROGRAMMING MODE

To program the setup parameters of the 3720 ACM from the front panel, you must first enter *programming mode*. To enter programming mode, press the two GROUP buttons together. When programming mode is first entered, 'PROGRAMMING MODE' is displayed.

You can return to display mode at any time by again pressing the two GROUP buttons together.

### 3.4.3 PROGRAMMING BUTTON FUNCTIONS

In programming mode, the buttons of the front panel take on new programming functions. The label below each button indicates its alternate function.

- **PARAMETER SELECT**  
Selects which parameter is displayed.
- **CURSOR**  
Moves the cursor left one digit. The cursor position wraps around to the right of the number if advanced past the left-most digit.
- **INCREMENT**  
Increments the digit under the cursor, advances through a number of preset values, or toggles a YES/NO option.

- **DECREMENT**

Decrements the digit under the cursor, advances through a number of preset values in reverse order, or toggles a YES/NO option.

### 3.4.4 ENTERING AND CHANGING THE PASSWORD

Pressing the PARAMETER SELECT button once advances past the 'PROGRAMMING MODE' display to the first programming mode parameter, the PASSWORD. When the 3720 ACM is shipped, the PASSWORD is 0. The correct PASSWORD must be entered if any parameter values are to be changed. If the password is not entered, setup parameter values may still be viewed, but not modified.

To change the password, the present password must first be entered. To change the password the PARAMETER SELECT button should be pressed repeatedly to advance past all parameters until the password parameter is displayed again. This time the new password should be entered. Once this has been done, returning to display mode changes the password.

### 3.4.5 ACCESSING AND MODIFYING PARAMETERS

#### Parameter Groups

To support the extensive functionality and flexibility that the 3720 ACM offers, a large number of user-programmable parameters are provided. To make field programming as efficient as possible, the parameters accessible via the front panel have been organized into 6 groups:

- Basic System Setup
- Auxiliary Setup
- Clear Functions
- Communications
- Front Panel Display
- Diagnostics

Each parameter group provides an *access parameter*. The default setting for all group access parameters is NO. If the value is not changed, pressing the PARAMETER SELECT button skips over that parameter group. If the value is set to YES, the PARAMETER SELECT button advances through each parameter within that group.

Advancing past all parameters within a group returns you to the access parameter for that group, with its value set to NO. You can then skip to the next group by pressing PARAMETER SELECT or gain access once more to the same group by setting the parameter to YES.

The entire parameter list wraps around. If a parameter group is missed, the PARAMETER SELECT button may be pressed repeatedly to return to the desired group.

Defining New Parameter Values

If the correct password was entered, you can modify any setup parameter. As discussed in Section 3.4.3, the CURSOR, INCREMENT and DECREMENT buttons can be used to change individual digits or select from a preset list of options for that parameter value. Section 3.4.6 lists all programmable parameters and their range of possible values.

If you attempt to set a parameter to a value outside of its allowed range, the display flashes the message 'INVALID ENTRY'. The message remains on the display until any button is pressed. The parameter is shown again with its previous value.

Parameter modifications are implemented immediately when you advance to the next parameter.

Returning to Display Mode

Once all parameters have been set to their desired values, pressing the two GROUP buttons together returns to display mode.

Programming Example

Figure 3.4.5 gives a step-by-step example of how to program three operating parameters from the front panel. The example given shows how to set the VOLTS MODE to DELTA the VOLTS SCALE to 277 and the AMPS SCALE to 2000.

3.4.6 OPERATING PARAMETER DESCRIPTIONS

Figures 3.4.6a to 3.4.6d provide a brief description of each operating parameter that may be programmed from the front panel. Figures 3.4.6e to 3.4.6l list all additional operating parameters which are only accessible via communications.

More detailed descriptions of each operating parameter are provided throughout this manual where operational features are described.

Figure 3.4.5 Field Programming Example

STEP	ACTION:	DISPLAY READS:
1.	Press the GROUP buttons together to enter programming mode.	PROGRAMMING MODE
2.	Press PARAMETER SELECT button once.	PASSWORD= ****
3.	Enter password by using INCREMENT and CURSOR buttons. To set to 0 (the default), press INCREMENT button once.	PASSWORD= ***0
4.	Press PARAMETER SELECT once.	SYSTEM SETUP= NO
5.	Press INCREMENT once to allow access to this parameter group.	SYSTEM SETUP= YES
6.	Press PARAMETER SELECT to advance to next parameter.	VOLTS MODE= 4W-WYE
7.	Press INCREMENT to advance to next parameter value.	VOLTS MODE= DELTA
8.	Press PARAMETER SELECT to advance to next parameter.	VOLTS SCALE= 120 <u>0</u>
9.	Enter new value (277) for VOLTS SCALE. Set far right digit to 7 by pressing INCREMENT until display reads:	VOLTS SCALE= 120 <u>7</u>
10.	Move cursor one digit left by pressing CURSOR button once.	VOLTS SCALE= 12 <u>0</u> 7
11.	Set next digit to 7 by pressing INCREMENT until display reads:	VOLTS SCALE= 12 <u>7</u> 7
12.	Move cursor 2 digits left by pressing CURSOR button twice.	VOLTS SCALE= <u>1</u> 277
13.	Set last digit to 0 by pressing DECREMENT once:	VOLTS SCALE= <u>0</u> 277
14.	Press PARAMETER SELECT to advance to next parameter	AMPS SCALE= 500 <u>0</u>
15.	Enter new value (2000) for AMPS SCALE. Move cursor three digits left by pressing CURSOR button three times.	AMPS SCALE= <u>5</u> 000
16.	Set digit to 2 by pressing DECREMENT three times:	AMPS SCALE= <u>2</u> 000
17.	Press the GROUP buttons together to return to display mode.	Volts, Phase, Amps, Function

NOTE: Cursor position in the example is shown as an underscore line. In the actual front panel display, cursor position is indicated by a blinking character.

Figure 3.4.6a Programmable Operating Parameters I

**Part I: Front Panel or Communications Access**

Parameter	Description	Range/Options
PROGRAMMING MODE	Initial display upon entering programming mode. Press PARAMETER SELECT to advance through each parameter.	
CLEAR MAX/MIN	Only if not password protected. See pages 3-10, 3-11.	
PASSWORD	Correct password must be entered to allow setup parameters to be modified or clear (reset) functions to be executed. Also used to redefine password. See Section 3.4.4.	4-digit number

**BASIC SYSTEM SETUP GROUP**

SYSTEM SETUP	Allows access to this group of parameters. Selecting NO (default) will advance to the next group.	NO • YES
<i>NOTE: Refer to Section 3.5 for more information on setting the following parameters.</i>		
VOLTS MODE	Defines the power system configuration.	4W-WYE • DELTA • SINGLE • DEMO • 3W-WYE
VOLTS SCALE	Defines the full-scale input reading (in Volts) for the phase A, B and C voltage inputs.	0 to 999,999

EXAMPLES	Direct Connect (Wye)			
System Configuration:	120 VAC line-neutral/208 VAC line-line	277 VAC line-neutral/480 VAC line-line	347 VAC line-neutral/600 VAC line-line	Using PTs
Set VOLTS SCALE to:	120	277	347	PT primary rating

AMPS SCALE	Defines the full-scale input reading (in Amps) for the phase A, B and C current inputs (CT primary current rating).	0 to 30,000
I4 SCALE	Defines the full-scale current reading (in Amps) for the I4 (neutral/ground) input.	0 to 9,999
STANDARD FREQ	Defines the line frequency the 3720 ACM is to monitor (in Hertz).	50 • 60
PHASE ROTATION	Defines the normal phase sequence used for PF polarity detection in delta mode, and for the <i>phase reversal detection</i> setpoint. See Chapter 5 for setpoint operation.	POS • NEG
NUM DEMAND PERIOD	Defines the number of demand periods to be averaged in calculating all sliding window demands.	1 to 15
PREDICT DMD BASE	Defines the base (in % of dmd. period) for predicted demand. Lower % = faster prediction.	1 to 99 (default = 5%) • 0 = off
DEMAND PERIOD	Defines the length of the demand period (in minutes) used in calculating all sliding window demand values.	1 to 99 • 0 = off
DEMAND SYN	Defines the method of demand synchronization. INTERNAL synchronizes to the onboard clock. EXTERNAL synchronizes to the S4 pulse.	INTERNAL • EXTERNAL
THERMAL PERIOD	Sets the time (in minutes) it takes the demand to reach 90% of the thermal constant for thermal demand measurements.	2 to 99 • 0 or 1 = off

Pressing PARAMETER SELECT returns to system setup parameter.

... continued



Figure 3.4.6b Programmable Operating Parameters I

**Part I: Front Panel or Communications Access**

Parameter	Description	Range/Options
<b>AUXILIARY SETUP GROUP</b>		
AUXILIARY SETUP		
Allows access to this group of	parameters. Selecting NO (default) will advance to the next group.	NO • YES
VAUX SCALE	Defines the reading for a full-scale (1.000 VAC) aux. voltage input. See Section 3.9.	0 to 999,999
VAUX ZERO	Defines the reading for a zero-scale (0.000 VAC) aux. voltage input. To define a negative number, toggle the 7th (i.e. most significant) digit.	-999,999 to 999,999
I OUT SCALE	Defines the reading of the associated parameter corresponding to a full-scale auxiliary current output. See Section 3.10. (Note: Frequency values must be entered x100. Example: 60 Hz = 6000)	0 to 999,999
IOUT ZERO	Defines the reading of the associated parameter corresponding to a zero-scale auxiliary current output. To define a negative number, toggle the 7th (i.e. most-significant) digit.	-999,999 to 999,999
I OUT KEY	Defines the measured parameter to which the current output will be proportional.	VOLTAGE A • VOLTAGE B • VOLTAGE C • VOLTAGE AV • CURRENT A • CURRENT B • CURRENT C • CURRENT AV • CURRENT I4 kW A • kW B • kW C • kVAR A • kVAR B • kVAR C • kVA A • kVA B • kVA C • kW TOTAL • kVAR TOTAL • kVA TOTAL • PF TOTAL • SD PARAMETER #1* • SD PARAMETER #2* • FREQUENCY • VAUX
	<i>*Note: SD parameters listed are the first 2 in the list of sliding window demand parameters defined by the user.</i>	
I OUT RANGE	Defines the output range for the auxiliary current output.	0-20mA • 4-20mA

*Pressing PARAMETER SELECT returns to the AUXILIARY SETUP parameter*

... continued



Figure 3.4.6c Programmable Operating Parameters I

**Part I: Front Panel or Communications Access**

Parameter	Description	Range/Options
<b>CLEAR FUNCTIONS GROUP</b>		
CLEAR FUNCTIONS	Allows access to this group of parameters. Selecting NO (default) will advance to the next group.	NO • YES
CLEAR MAX/MIN?	Selecting YES resets the Preset and all Programmable Max/Min Logs when PARAMETER SELECT is pressed.	NO • YES
CLEAR HOURS?	Selecting YES resets kWh, kVARH, and kVAH counters to zero when PARAMETER SELECT is pressed. Note: T.O.U. energy registers are not affected.	NO • YES
CLEAR STATUS COUNT	Selected status input counter total(s) are cleared when PARAMETER SELECT is pressed.	0 (none) • 1 • 2 • 3 • 4 • ALL

*Pressing PARAMETER SELECT returns to the CLEAR FUNCTIONS parameter.*

**COMMUNICATIONS GROUP**

COMMUNICATIONS	Allows access to this group of parameters. Selecting NO (default) will advance to the next group.	NO • YES
COMM CARD	Identifies the communication card installed.	ISOCOM 2 • MULTIPORT
COMM PORT A COMM PORT B* COMM PORT C* *Ports B & C - MPCC only	These three parameters permit access to the setup menus of each communication port. The communication parameters that follow can be set independently for each port.	NO • YES
PROTOCOL	Defines the active protocol. Selecting NONE disables the port.	PML 3720 • MODBUS • NONE • AB DF-1 (MPCC ONLY), PML 3720 AD (MPCC ONLY)
CONFIG PML 3720 (ISOCOM ONLY)	Provides access to the configuration parameters for the PML 3720 protocol.	NO • YES
CONFIG MODBUS (ISOCOM ONLY)	Provides access to the configuration parameters for the Modbus protocol.	NO • YES
UNIT ID	Defines the communications identification (ID) number for the 3720 ACM.	1 to 9999 for PML 3720 protocol 1 to 247 for Modbus protocol 1 to 99 for AB DF-1 protocol
REGISTER SIZE	Specifies if registers are 16 or 32 bit. The default is 16B. (This parameter only appears for Modbus setup.)	16B • 32B
BAUD RATE	Defines the baud rate.	300 • 1200 • 2400 • 4800 • 9600 • 19200 MPCC <u>ONLY</u> : 38400 • 57600 • 115200
COMM MODE (ISOCOM ONLY)	View comm. mode (set by jumper block on comm. card. See Chapter 2, Sect. 2.6.2)	RS-232 • RS-485

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### Figure 3.4.6d Programmable Operating Parameters I

### ***Part I: Front Panel or Communications Access***

Parameter	Description	Range/Options
RTS ACTIVE LVL	Sets the active logic level asserted by the RTS line when using RS-232 communications (refer to Chapter 9).	LOW • HIGH
US ACK/NAK (ISOCOM ONLY)	Determines if the 3720 ACM will request acknowledgement from master. The default is NO. (This parameter only appears for PML 3720 setup.)	NO • YES
INVALID OBJECTS	Specifies if the 3720 ACM returns a value for an invalid object. If set to YES, the invalid register will contain either 0 or 0xFFFF. (This parameter only appears for Modbus setup.)	NO • YES
PASSWORD PROTECT	Provides password protection for all configurations and relay operations. Functionality depends on the communications software used. The default is NO. (Note that POWER MEASUREMENT's SCADA software requires this to be set to NO.)	NO • YES
TRANSMIT DELAY	Sets the delay between asserting RTS and the transmission of the first bit.	0 to 999 ms

*Pressing* **PARAMETER SELECT** returns to the **COMMUNICATIONS** parameter.

## FRONT PANEL DISPLAY GROUP

DISPLAY	Allows access to this group of parameters. Selecting NO (default) will advance to the next group.	NO • YES
DISPLAY TIMEOUT	Duration (in minutes) between last button press and entering display-saver mode.	0 (stay on) • 1 to 999 (minutes)
FORMAT	Defines numeric format. 1,234.5 is default.	1,234.5 • 1234,5
PHASE LABEL	Defines the phase label format.	ABC • XYZ • RYB • RST
RESTORE DISPLAY	Used to restore front panel display brightness. Selecting YES lights all segments of display upon exit from programming mode. See Section 3.6.	NO • YES
VOLTS	Selects primary or secondary volts display.	PRIMARY • SECONDARY
AMPS	Selects primary or secondary amps display.	PRIMARY • SECONDARY
PROTECT MIN/MAX	Enables password protection on clearing of MAX/MIN.	YES • NO

*Pressing **PARAMETER SELECT** returns to the **DISPLAY** parameter.*

**DIAGNOSTICS GROUP**

DIAGNOSTICS	Allows access to this group of parameters. Selecting NO (default) returns to PASSWORD.	NO • YES
FIRMWARE VER	Firmware version currently installed.	WWW X.X.X.X WWW = standard or custom (V = standard) X.X.X.X = version number
CARD REV (MPCC ONLY)	MPCC firmware version	AS DIRECTLY ABOVE
EXTENDED	Allows access to an extended group of diagnostic parameters using a special button combination from display mode. See Section 4.6 for instructions and list of extended parameters.	NO • YES
CLEAR DIAG CODES	Reset communications diagnostics.	YES • NO

*Pressing* **PARAMETER SELECT** returns to the **DIAGNOSTICS** parameter.

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Figure 3.4.6e Programmable Operating Parameters II

**Part II: Communications Access Only**

Parameter	Description	Range/Options
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**WAVEFORM RECORDER SETUP**

WFR CONFIGURATION	Configures storage for the Waveform Recorder. Option format = # of events x cycles/event.	3x12 • 2x18 • 1x36
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**SLIDING WINDOW DEMAND SETUP**

*Only the additional demand setup parameters not available from the front panel of the 3720 ACM are listed here.*

SWD PARAMETER	Selects one of ten sliding window demand measured parameters to configure.	1 to 10
PARAMETER TYPE	Defines the type of measured parameter. NOT USED disables the selected parameter.	NOT USED • VOLTAGE LN • VOLTAGE LL • CURRENT • kW • kVA • kVAR • PF • FREQUENCY • THD • HD ODD • HD EVEN • HDxx (xx = 2 to 15) • K-FACTOR
INPUT	Selects the phase or input for the selected parameter type, if applicable.	A • B • C • AVG • TOT • I4 • VAUX
PREDICTED DEMAND BASE	Sets the sensitivity of the demand prediction. Smaller value provides faster response. Default is 5%. See Section 4.3.1.	0 (disable all) • 1 to 99

**STANDARD SETPOINTS SETUP**

*The following three parameters define the measured parameter:*

STD SETPOINT	Selects one of the eleven standard setpoints to be programmed.	1 to 11
PARAMETER TYPE	Defines the type of parameter the selected setpoint is to monitor. A setting of NOT USED disables the setpoint. See Chapter 6 for setpoint type descriptions.	NOT USED • OVER VOLTAGE LN • OVER VOLTAGE LL • UNDER VOLTAGE LN • UNDER VOLTAGE LL • VOLTAGE UNBALANCE • OVER CURRENT • UNDER CURRENT • CURRENT UNBALANCE • PHASE REVERSAL • OVER kW IMP • OVER kW EXP • OVER kVAR IMP • OVER kVAR EXP • OVER kVA • OVER kWD • OVER KVAD • OVER FREQ • UNDER FREQ • UNDER PF LAG • UNDER PF LEAD • STATUS x INACTIVE (x = 1 to 4) • STATUS x ACTIVE (x = 1 to 4) • ANY STATUS INACTIVE • ANY STATUS ACTIVE • OVER Sx COUNTER (x = 1 to 4) • OVER THD, OVER HD ODD • OVER HD EVEN • OVER HDxx (where xx = 2 to 15) • K-FACTOR • NEW HOUR • NEW DAY • NEW WEEK • NEW MONTH • NEW YEAR
INPUT	Selects the phase or input for the selected parameter type, if applicable.	A • B • C • AVERAGE • TOTAL • I4 • VAUX

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Figure 3.4.6f Programmable Operating Parameters II

**Part II: Communications Access Only**

Parameter	Description	Range/Options
MEASUREMENT MODE	Defines the variation of measurement for the selected parameter type, if applicable.	RT • RT MIN • RT MAX • (RT = real-time) TD • TD MIN • TD MAX • (TD = thermal demand) SD • SD MIN • SD MAX • (SD = s. w. demand) PD • PD MIN • PD MAX • (PD = predicted demand)
HIGH LIMIT	Defines the high limit for the selected setpoint.	-999,999 to 999,999
LOW LIMIT	Defines the low limit for the selected setpoint.	-999,999 to 999,999
TIME DELAY OPERATE	Defines the time delay to operate (in seconds) for the selected setpoint.	0 to 32,000
TIME DELAY RELEASE	Defines the time delay to release (in seconds) for the selected setpoint.	0 to 32,000
ACTION 1	Defines the first of two possible actions triggered when the selected standard setpoint becomes active. Note: Action 1 is always executed <i>first</i> . See Chapter 6.	NOT USED • RELAY 1 • RELAY 2 • RELAY 3 • WAVE CAPTURE <sub>xx</sub> (xx = V1, V2, V3, I1, I2, I3, I4, VX) • WAVE RECORDER • SNAPSHOT x (x = 1 to 8) • CLEAR TOU ENERGY REGISTER x (x = 1 to 3, ALL) • CLEAR TOU DEMAND REGISTER x (x = 1 to 3, ALL) • CLEAR ALL TOU REGISTERS • CLEAR PRESET RT MIN/MAX LOGS* • CLEAR PRESET TD MIN/MAX LOGS* • CLEAR PRESET SD MIN/MAX LOGS* • CLEAR PRESET PD MIN/MAX LOGS* • CLEAR PRESET HARM.DIST. MIN/MAX* • CLEAR PRESET HARM.DIST. TD MIN/MAX* • CLEAR PROGRAMMABLE MIN/MAX x (x=1 to 8)* • CLEAR ALL MIN/MAX LOGS (preset & programmable) • CLEAR Sx COUNTER (x = 1 to 4, ALL) •
ACTION 2	Defines the second of two possible setpoint actions. Note: Action 2 is always executed <i>following</i> any specified Action 1. See Chapter 6.	See ACTION 1 above for range of options.
<b>HIGH-SPEED SETPOINTS SETUP</b>		
HIGH SPD SETPOINT	Selects one of the six high-speed setpoints to be programmed.	1 to 6
PARAMETER TYPE	Defines the type of parameter the selected setpoint is to monitor. A setting of NOT USED disables the setpoint. Curve characteristics for TIME OVERCURRENT type must be programmed separately - see TIME OVERCURRENT SETUP section.	NOT USED • OVER VOLTAGE • UNDER VOLTAGE • VOLTAGE UNBALANCE • OVER CURRENT • UNDER CURRENT • CURRENT UNBALANCE • OVER I4 • PHASE REVERSAL • OVER kW IMP • OVER kW EXP • OVER kVA • OVER FREQUENCY • UNDER FREQUENCY • TOC (time-overcurrent) • STATUS x INACTIVE (x = 1 to 4) • STATUS x ACTIVE (x = 1 to 4) • ANY STATUS INACTIVE • ANY STATUS ACTIVE • OVER Sx COUNTER (x = 1 to 4)
INPUT	Selects the phase for the selected parameter type, if applicable.	A • B • C • AVERAGE • TOTAL

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Figure 3.4.6g Programmable Operating Parameters II

**Part II: Communications Access Only**

Parameter	Description	Range/Options
HIGH LIMIT	Defines the high limit for the selected setpoint.	0 to 999,999
LOW LIMIT	Defines the low limit for the selected setpoint.	0 to 999,999
TIME DELAY OPERATE	Defines the time delay to operate (in cycles) for the selected setpoint.	0 to 32,000
TIME DELAY RELEASE	Defines the time delay to release (in cycles) for the selected setpoint.	0 to 32,000
ACTION 1	Defines the first of two possible actions triggered when the selected high-speed setpoint becomes active. NOT USED •	RELAY 1 • RELAY 2 • RELAY 3 • WAVE CAPTURE <sub>xx</sub> (xx = V1, V2, V3, I1, I2, I3, I4, VX)* • WAVE RECORDER • SNAPSHOT 8 (High-Speed Snapshot Log) • CLEAR Sx COUNTER (x = 1 to 4, ALL) •
ACTION 2	Defines the second of two possible actions triggered when the selected high-speed setpoint becoming active.	See ACTION 1 above for range of options.

**TIME-OVERCURRENT CURVE SETUP**

*This parameter group is used to configure the time-overcurrent curve used for all high-speed setpoints defined as TIME OVERCURRENT type. See Chapter 5.*

HIGH SPEED FEATURE	Specifies the active high speed feature: Time-Overcurrent Curve (TOC), or High-Speed Snapshot (HSS) Log. Default is TOC.	TOC • HSS
MAX CURRENT	Defines the maximum (pickup) current for the time-overcurrent curve.	1 to 30,000
DATA PTS	Selects one of the eight data points on the curve characteristic to be defined.	0 to 8
xCURRENT	Defines the X (current) coordinate for the selected curve point. Specified in multiples of MAX CURRENT parameter value.	1.00 to 110.00
TIME	Defines the Y (time) coordinate for the selected curve point (in milliseconds).	33 to 10,000

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Figure 3.4.6h Programmable Operating Parameters II

**Part II: Communications Access Only**

Parameter	Description	Range/Options
<b>RELAY SETUP</b>		
RELAY CONTROL	Selects one of the three relays to be programmed.	1 to 3
MODE	Defines the type of operation the selected relay is to perform. See Section 3.7	SETPOINT • kWH IMP (pulsing) • kWH EXP • kWH TOT • kVARH IMP • kVARH EXP • kVARH TOT • kVAH
VALUE	For Rx MODE = SETPOINT: Specifies <i>latch</i> mode or sets <i>pulse</i> mode duration (in seconds). For Rx MODE = kWH, kVARH, or kVAH pulsing, disables pulsing or defines number of unit-hours between pulses. 0 = latch mode or disable pulsing	1 to 65535 = pulse duration or unit-hours
<b>STATUS INPUT COUNTER SETUP</b>		
STATUS COUNTER	Selects the status input counter to be programmed.	1 to 4
RESOLUTION	Fixes the decimal resolution for the selected counter. Default is 0.	0 to 3
SCALE FACTOR	Specifies the value represented by one pulse on the selected counter input (in units/pulse). Default is 1.	0.001 to 1000
ROLLOVER	Specifies the maximum range before the selected counter rolls over to 0 (zero). Default is 999,999,999.	0 to 999,999,999
PRESET	Presets the counter reading to a specific value. Note: Counter will rollover to 0, not preset value.	0 to 999,999,999
<b>EVENT LOG SETUP</b>		
LOG STATUS CHANGES?	Selects whether status input events will be logged. Default is YES. User must select for each individual status input.	YES • NO

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Figure 3.4.6i Programmable Operating Parameters II

**Part II: Communications Access Only**

Parameter	Description	Range/Options
<b>STANDARD SNAPSHOT LOGS SETUP</b>		
SNAPSHOT LOG	Selects one of eight snapshot logs to configure.	1 to 8
MEMORYALLOCATION	Defines the memory allocated in snapshot memory for the selected log. See Section 7.4 for information on memory requirements.	0 to 100%
TRIGGER TYPE	Defines the triggering method for the selected log. If SETPOINT is defined, the desired setpoint must be programmed to trigger the selected log. See STANDARD SETPOINTS SETUP above.	INTERVAL • SETPOINT
INTERVAL	Defines the time interval between snapshots. If TRIGGER TYPE = INTERVAL, logging will run continuously at specified intervals. If TRIGGER TYPE = SETPOINT, logging will occur at specified intervals only while setpoint is active.	DAYS: 1 to 399 • HOURS: 1 to 23 MINUTES: 1 to 59 • SECONDS: 1 to 59
PARAMETER NUMBER	Selects one of twelve possible measured parameters for the selected log to be defined.	1 to 12
<i>The following three parameters define the measured parameter:</i>		
PARAMETER TYPE	Defines the type of measured parameter.	VOLTAGE LN • VOLTAGE LL • VOLTAGE UNBAL • CURRENT • CURRENT UNBAL • PHASE REVERSAL • kW • kVAR • kVA • kWH • kVARH • kVAH • PF • FREQ • THD • HD EVEN • HD ODD • HDxx (xx = 2 to 15) • K-FACTOR • DATE/TIME • TOU ENERGY REGISTER • TOU DEMAND REGISTER • ACTIVE TARIFF • ACTIVE PROFILE • RELAY OUTPUT • STATUS CONDITION • STATUS COUNT • SETPOINT CONDITION
INPUT	Selects the phase, input, output, register, or setpoint number for the selected parameter type, if applicable.	A • B • C • AVG • TOT • I4 • VAUX • 1 • 2 • 3 • R1 • R2 • R3 • S1 • S2 • S3 • S4 • SPxx (xx = 1 to 11) • HSxx (xx = 1 to 6)
MEASUREMENT MODE	Defines the variation of measurement for the selected parameter type, if applicable.	RT • RT MIN • RT MAX • TD • TD MIN • TD MAX • SD • SD MIN • SD MAX • PD • PD MIN • PD MAX • IMP • EXP • NET • TOT • TARIFF x (x = 1 to 10)

... continued



Figure 3.4.6j Programmable Operating Parameters II

**Part II: Communications Access Only**

Parameter	Description	Range/Options
<b>HIGH-SPEED SNAPSHOT LOG SETUP</b>		
<i>HIGH SPEED FEATURE parameter must be set to HSS to enable the High-Speed Snapshot Log and disable Time-Overcurrent. See HIGH SPEED FEATURE under Time-Overcurrent Setup. Note: High-Speed Log is always Snapshot Log #8.</i>		
MEMORY ALLOCATION	Defines the memory allocated in snapshot memory for the high-speed log. See Section 7.4 for information on memory requirements.	0 to 100%
TRIGGER TYPE	Defines the triggering method. MANUAL requires a trigger command received via the comm. port. If SETPOINT is defined, the setpoint must be programmed to trigger the high-speed log. See SETPOINTS SETUP above. Note: Only 1 setpoint trigger is possible prior to rearming the high-speed log.	MANUAL • SETPOINT
STOP CONDITION	Defines the condition following a trigger that will stop the high-speed logging function.	LOG FULL = stop when allocated memory is used up. TIMED OUT = stop when DURATION has passed. SETPT OFF = stop when setpoint returns to inactive.
DURATION	If STOP CONDITION = TIMED OUT, specifies number of cycles until logging is stopped, in increments of 2 cycles.	0 to 130,000
INTERVAL	Defines the time interval between snapshots in increments of 2 cycles. Logging will run continuously at specified intervals until stop condition is reached. See Section 8.4.2 for configuring a 1-shot mode.	0 to 130,000
PARAMETER NUMBER	Selects one of twelve possible measured parameters for the high-speed log to be defined.	1 to 12
<i>The following two parameters define the measured parameter:</i>		
PARAMETER TYPE	Defines the type of measured parameter.	VOLTAGE HS (LN or LL dependent on voltage mode) • VOLTAGE UNBAL HS • CURRENT HS • PHASE REVERSAL HS • kW • kVA • FREQUENCY • STATUS CONDITION • STATUS COUNT
INPUT	Selects the phase or input for the selected parameter type, if applicable.	A • B • C • AVG • TOT • I4 • S1 • S2 • S3 • S4
<b>DAYLIGHT SAVINGS TIME SETUP</b>		
TIME OF CHANGE	Specifies the beginning or the end of a daylight savings time period. See Section 3.11 for more details.	Date given in the format YY/MM/DD/ HH:MM:SS MM should be in increments of 15 (00, 15, 30, 45)
CHANGE TO	Indicates what the new time should be when you switch to or from daylight savings time. Normally this would be 1 hour different from TIME OF CHANGE. See Section 3.11 for more details.	Date given in the format YY/MM/DD/ HH:MM:SS MM should be in increments of 15 (00, 15, 30, 45) SS should be 00

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Figure 3.4.6k Programmable Operating Parameters II

**Part II: Communications Access Only**

Parameter	Description	Range/Options
<b>GROUP BUTTONS SETUP</b>		
GROUP BUTTON	Selects which GROUP button to configure.	1 • 2
PARAMETER NUMBER	Selects the measured parameter to be defined.	1 to 18
<i>The following three parameters define the measured parameter:</i>		
PARAMETER TYPE	Defines the type of measured parameter.	VOLTAGE LN • VOLTAGE LL • VOLTAGE UNBAL • CURRENT • CURRENT UNBAL • kW • kVAR • kVA • kWh • kVARH • kVAH • PF • FREQ • THD • HD EVEN • HD ODD • HDxx (xx = 2 to 15) • K-FACTOR • DATE/TIME • TOU ENERGY REGISTER • TOU DEMAND REGISTER • ACTIVE TARIFF • ACTIVE PROFILE • RELAY OUTPUT • STATUS CONDITION • STATUS COUNT • SETPOINT CONDITION
PHASE BUTTON	Defines the sequence of phases, inputs, setpoint numbers, or harmonic numbers accessible using the PHASE button. List of available options is dependent on the PARAMETER TYPE defined above.	Any phase sequence • Any 3-phase display • Any relay or status input sequence • Any setpoint sequence • Any combination of other measured or status parameters
MODE FUNCTION	Defines the sequence of measurement variations accessible using the MODE function, if applicable. Options listing only a single mode will effectively disable the MODE function, since no additional modes will be available to the user.	Any combination of modes, including RT • TD • SD • MIN • MAX • IMP • EXP • NET • TOT
<b>PROGRAMMABLE MINIMUM/MAXIMUM LOGS SETUP</b>		
MIN/MAX LOG	Selects one of sixteen min/max logs to configure.	1 to 16
PARAMETER NUMBER	Selects the min/max <i>trigger</i> or one of the 15 possible <i>coincident</i> parameters for the selected log to be defined. Parameter 1 is the trigger parameter.	1 to 16
<i>The following three parameters define the measured parameter:</i>		
PARAMETER TYPE	Defines the type of measured parameter.  <i>* Note: Parameter types and modes marked by an asterisk cannot be used as the min/max trigger, but can be defined as coincident parameters.</i>	VOLTAGE LN • VOLTAGE LL • VOLTAGE UNBAL • CURRENT • CURRENT UNBAL • PHASE REVERSAL* • kW • kVAR • kVA • kWh* • kVARH* • kVAH* • PF • FREQ • THD • HD EVEN • HD ODD • HDxx (xx = 2 to 15) • K-FACTOR • DATE/TIME* • TOU ENERGY REGISTER* • TOU DEMAND REGISTER* • ACTIVE TARIFF* • ACTIVE PROFILE* • RELAY OUTPUT* • STATUS CONDITION* • STATUS COUNT* • SETPOINT CONDITION*
INPUT	Selects the phase or input for the selected parameter type, if applicable.	A • B • C • AVERAGE • TOT • I4 • VAUX
MEASUREMENT MODE	Defines the variation of measurement for the selected parameter type, if applicable.	RT • TD • SD • MIN* • MAX* • IMP* • EXP* • NET* • TOT*

Figure 3.4.6 I Programmable Operating Parameters II

**Part II: Communications Access Only**

Parameter	Description	Range/Options
<b>STATUS INPUT AND RELAY LABELS SETUP</b>		
STATUS x INACTIVE	Defines the label for the inactive state of status input x (where x = 1 to 4).	20 character label
STATUS x ACTIVE	Defines the label for the active state of status input x (where x = 1 to 4).	20 character label
RELAY x INACTIVE	Defines the label for the inactive (released) state of relay x (where x = 1 to 3).	20 character label
RELAY x ACTIVE	Defines the label for the active (operated) state of relay x (where x = 1 to 3).	20 character label
<b>TIME-OF-USE SETUP</b>		
<i>Note: TOU parameters are programmable using Power Measurement's WinTOU Setup utility.</i>		
<b>Configuring the Calendar</b>		
MONTH	Selects a month from a 2 year range to program.	JAN • FEB • MAR • APR • MAY • JUN • JUL • AUG • SEP • OCT • NOV • DEC
DAY	Selects a day of the month to apply a profile.	1 to 31
PROFILE	Selects one of 16 daily profiles.	1 to 16
<b>Configuring Daily Profiles</b>		
PROFILE SETUP	Selects one of 16 daily profiles to program.	1 to 16
SELECT TARIFF	Configures each profile with up to 8 tariff changes Select from up to 10 possible tariffs.	1 to 10
<b>Configuring the Tariff Table</b>		
ENERGY REGISTER	Selects one of 3 energy registers to define. Each register is available to all 10 tariffs.	1 to 3
ENERGY PARAMETER	Defines the parameter for the energy register.	kWH IMP • kWH EXP • kWH NET • kWH TOT • kVARH IMP • kVARH EXP • kVARH NET • kVARH TOT • kVAH
DEMAND REGISTER	Selects one of 3 demand registers to define. Each register is available to all 10 tariffs.	1 to 3
DEMAND PARAMETER	Defines the parameter for the energy register. <b>Note:</b> These parameters used only by the TOU system represent <i>peak</i> demand values.	kW TOT SD • kW TOT TD • kVAR TOT SD • kVAR TOT TD • kVA TOT SD • kVA TOT TD • AMPS AVG SD • AMPS AVG TD
PENALTY TARIFF	Configures one of the 10 tariffs as the penalty tariff. 0 (zero) disables this feature.	0 • 1 to 10

### 3.5 SETTING THE VOLTS SCALE, AMPS SCALE, I4 SCALE, VOLTS MODE, AND STANDARD FREQUENCY

This section details the minimum basic programming setup required for proper operation of the 3720 ACM.

#### Volts Scale

The setting of the VOLTS SCALE parameter depends on the voltage of the system being monitored and whether the 3720 ACM is connected directly to the lines, or if PTs are used.

#### WARNING

PTs are required for connection to all Delta systems.

#### Direct Connection

The various phase voltage input options of the 3720 ACM support direct connection to Wye systems up to 347 VAC line-to-neutral / 600 VAC line-to-line and Single Phase systems up to 347 VAC line-to-neutral / 694 VAC line-to-line without the need for PTs.

For direct connection, the VOLTS SCALE parameter of the 3720 ACM must be set to the full scale rating of its phase voltage inputs. The basic model provides 120 VAC voltage inputs, which allow for direct connection to Wye systems up to 120 VAC line-to-neutral / 208 VAC line-to-line and Single Phase systems up to 120 VAC line-to-neutral / 240 VAC line-to-line. For the basic model, VOLTS SCALE must be set to 120.

Similarly, a 3720 ACM equipped with the 277 option must be set for a VOLTS SCALE of 277, while units with the 347 option must be set to a VOLTS SCALE of 347.

For system voltages between the ratings of the input options provided by the 3720 ACM, the next highest input option should be used. For example, to monitor a 220 VAC line-to-neutral / 381 VAC line-to-line Wye system, a 3720 ACM equipped with the 277 option should be used. In this case, the VOLTS SCALE must still be set to 277.

#### PT Connection

PTs must be used for Wye systems above 347 VAC line-to-neutral / 600 VAC line-to-line, Single Phase systems above 347 VAC line-to-neutral / 694 VAC line-to-line, and for *all* Delta systems.

When using PTs, the VOLTS SCALE set for the 3720 ACM is dependent on the primary and secondary ratings of the PTs used.

For PTs that provide secondaries up to 120 VAC, use a basic model 3720 ACM (120 VAC inputs). If the PTs have secondaries rated at 120 VAC, set the VOLTS SCALE to the primary rating of the PT. For example, for a 13.8 kV system, 120:1 ratio PTs with primary ratings of 14.4 kV are typically used. For these PTs, set the VOLTS SCALE to 14400.

If the secondaries of the PTs are not rated at 120 VAC (i.e. 100, 110, etc.), use the following formula to determine the required VOLTS SCALE :

$$\text{VOLTS SCALE} = \frac{\text{PT Primary Rating}}{\text{PT Secondary Rating}} \times 120$$

For PTs that provide secondaries with ratings between 120 and 277 VAC (i.e. 220), use a 3720 ACM equipped with the 277 option. Use the following formula to determine the required VOLTS SCALE :

$$\text{VOLTS SCALE} = \frac{\text{PT Primary Rating}}{\text{PT Secondary Rating}} \times 277$$

#### Amps Scale (phases A, B, and C)

The basic model 3720 ACM provides 5 Amp phase current inputs. If the CTs used are rated for a 5 Amp full scale output, set the AMPS SCALE to the Primary Rating of the A, B, and C phase CTs being used.

The 3720 ACM also offers a 1AMP option which for use with CTs with 1 Amp full scale output.

If the CTs are not rated for a 5 Amp or 1 Amp full scale output, contact POWER MEASUREMENT or your local representative for more information.

#### NOTE

For the above parameter settings,

$$\text{VOLTS SCALE} \times \text{AMPS SCALE}$$

should be less than 999,999,999 for correct display of kW, kVAR, and kVA readings which have a maximum range of 999.999K.

#### I4 Scale

The 3720 ACM has a fourth current input, designated I4. This input uses connections I41 and I42 on the terminal strip. Typically, this input is used to measure current in the neutral conductor. In installations with non-linear loads, odd harmonics can fail to cancel, producing significant currents in the neutral conductor.

The ratings of this input are identical to the three phase current inputs (5 Amps for the basic model, 1 Amp for the 1AMP option).

The I4 SCALE parameter of the 3720 ACM specifies the scaling for the I4 input. This scaling is independent of the phase A, B, and C current inputs. This allows for a different primary rating for the CT used for the I4 input. The I4 SCALE should be set to the primary rating of the CT being used for the I4 current input. This only applies if the CT used is rated for a 5 Amp full scale output. If the CT is not rated for a 5 Amp full scale output, contact the POWER MEASUREMENT factory.

The I4 reading may be displayed from the front panel using the FUNCTION button.

### Volts Mode

The VOLTS MODE should be set according to the system connection configuration (4W-WYE, 3W-WYE, DELTA, SINGLE). Refer to Section 2.5 and Figures 2.5.7a to 2.5.9 for more information.

The 3720 ACM also offers a *demonstration mode* which generates dynamic readings for all real-time measurements based on the input scales you program. These readings can be viewed from the front panel or via communications. To use this feature, set VOLTS MODE to DEMO.

### Standard Frequency

The STANDARD FREQ parameter should be set according to the frequency of the power signal the 3720 ACM is to be monitoring. Options include 50 or 60 Hz.

It is important that this parameter is set correctly, as the accuracy of the kW, kVAR, and power factor measurements can be seriously affected.

## 3.6 DISPLAY FORMAT

The 3720 ACM front panel display can present numeric information and phase labels in a number of different formats which reflect various world and industrial standards. Two programmable parameters are used to define the display format:

### FORMAT

This parameter allows you to select formats for numeric information. The front panel display can present measured values using either of the two following numeric formats:

- 1,234.5  
This is the default. A comma is used for the thousands delimiter (radix), and a decimal point is used for the decimal delimiter.
- 1234,5  
No thousands delimiter is used, and a comma is used for the decimal delimiter.

### PHASE LABELS

This parameter defines the three letters used for the phase labels. The possible choices are ABC (default), XYZ, RYB and RST.

## 3.7 CONTROL RELAY OPERATION

The 3720 ACM provides three control relays (R1 to R3). Each relay can switch AC loads of up to 277 Volts at 10 Amps and DC loads of up to 30 Volts at 10 Amps. Chapter 2 provides wiring requirements for the relays.

The operation of each relay may be controlled in a number of different ways for various applications:

- Setpoint control on selected measured parameters, controlled by user-definable conditions. This is useful for applications such as activation of alarms or tripping of breakers for demand, power factor, or load control. Setpoint operation is described in detail in Chapter 6.
- kWh, kVARh, or kVAh pulse output.
- Manual forced control by the user through remote commands made via the communications port. This must be performed via using an IBM PC running POWER MEASUREMENT's SCADA software, or a compatible third-party system.

A group of programmable operating parameters has been provided which assign relay operation. These are accessible via communications only. The parameters allow each of the three relays to be assigned to setpoints (in *latch* or *pulse* mode), kWh pulsing, kVARh pulsing, or kVAh pulsing. POWER MEASUREMENT's SCADA system provides configuration screens for redefining the relay parameters.

### Setpoint Relay Operation

For setpoint operation, the relays can provide latched or pulsed operation. In latch mode, the relay is operated (i.e. normally open contacts are closed) for the duration that the assigned setpoint is active. In pulsed mode, when the setpoint becomes active the relay operates for a specified pulse duration.

Set MODE to SETPOINT for setpoint operation. Set VALUE to select latch mode (VALUE = 0), or to set the pulse duration for pulse mode operation (in seconds).

### CAUTION

While you are programming the 3720 ACM via communications, no setpoint-controlled relay operation occur until after you complete the programming sequence. The 3720 ACM then assesses the status of each setpoint and performs any required operations.

## kWh, kVARh OR kVAh Pulse Operation

Each relay can be configured for energy pulsing. Pulses can be based on kWh Imported, kWh Exported, kWh Total, kVARh Imported, kVARh Exported, kVARh Total, or kVAh. The **MODE** parameter is used to set the type of pulsing. The **VALUE** parameter is used to set the number of unit-hours between pulses.

### NOTE

1. A relay configured for energy pulsing will not respond to an assigned setpoint that becomes active.
2. Maximum pulse rate for the relays is 1 pulse every 2 seconds (0.5 Hz).

## Manual Forced Relay Operations

Only a setpoint relay (**RX MODE** = **SETPOINT**) may be forced operated or released using commands made via communications. Manual commands override current setpoint condition.

If the relay is operating in *pulse* mode (**RX VALUE** > 0), a forced operate command initiates a pulse of length equivalent to the value set by the **RX VALUE** parameter for that relay. This operation is logged in the event log and indicates that the relay was pulsed. A forced release command has no effect.

If the relay is operating in *latch* mode (**RX VALUE** = 0), it behaves normally for forced operate, forced release, and return to normal (return to setpoint control) commands.

See below for manual relay control special cases.

## Relay Event Logging

For a relay assigned to setpoint operation (**MODE** = **SETPOINT**), the Event Log logs relay operations in one of two ways, depending on whether the relay has been set to operate in latch or pulse mode:

- Latch mode (**VALUE** = 0): The event log records that the relay was operated (**ON**) when the setpoint becomes active and released (**OFF**) when the setpoint returns to an inactive state.
- Pulse mode (**VALUE** > 0): The event log shows that the relay is pulsed when the setpoint becomes active. When the setpoint returns to its inactive state, the setpoint event is logged, but does not indicate the relay, since no pulse is generated.

If the relay is assigned to kWh, kVAh or kVAh PULSE mode, no relay operations are logged.

Manual forced relay commands are logged in the Event Log; however special cases exist which are described below.

## Manual Relay Command Special Cases

If a manual forced operate command for a selected relay is received while that relay is currently in a forced operated state, the relay command is ignored, and is not logged. This also holds true for a forced release command to a relay already in a forced released state. Manual relay commands made to relays which are in a kWh, kVAh or kVAh PULSE mode will also not be logged.

## 3.8 STATUS INPUT OPERATION

The 3720 ACM provides four digital *status* inputs (S1 to S4) which can each be used to sense the condition of an external dry (volts free) contact. Chapter 2 provides wiring diagrams illustrating various requirements and connection methods for the status inputs.

A minimum pulse width of 40 milliseconds is required for reliable sensing of status input changes. The status inputs may only be used for external contact sensing. In this application, a contact closure is sensed as **ACTIVE**, and a contact opening is sensed as **INACTIVE**.

### Pulse Counting

The 3720 ACM maintains a counter for each of the four status inputs. The maximum frequency the counter accurately follows is 10 Hz. A number of programmable parameters, accessible via communications, are provided to allow each counter to be customized for specific applications.

### RESOLUTION

The decimal resolution for each counter can be fixed between 0 and 3. For example, a setting of 3 would display a total pulse count of 1234 as 1.234.

### SCALE FACTOR

This parameter allows the total pulse count to be scaled by a factor of 0.001 to 1000 units per pulse. For example, a setting of 200 would display a total pulse count of 10 as 2,000.

### ROLLOVER

The maximum (scaled) reading that each counter can achieve prior to rollover to 0 (zero) can be defined. The default is 999,999,999. This is the maximum range of the counters.

### PRESET

You can preset each counter reading to a specific value. This is a 1-shot function only. If the counter rollover value is reached, it rolls over to zero, not to the preset value. If the counter is zeroed, as described below, its reading returns to the preset value once again.



### Resetting the Status Input Counters

Status input counter values can be manually reset to zero (0) using the CLEAR STATUS COUNT parameter from the front panel in programming mode or via communications. Each counter can be cleared individually, or all counters can be cleared together.

Counters can also be automatically reset using setpoints (see Chapter 6).

### Demand Sync

Status Input S4 can be used to provide external demand interval synchronization for demand measurements. Refer to Chapter 4, Section 4.3.1 for more information.

### TOU Penalty Tariff Activation

Status Input S3 can be used to activate the penalty tariff used by the 3720 ACM Time-Of-Use register system. If you have defined a penalty tariff, the tariff remains in effect for the entire duration that an active level (i.e. contact closure) is present on Status Input S3. Refer to Chapter 5 for more information on Time-Of-Use.

#### NOTE

If the TOU penalty tariff is in use, Status Input S3 is *disabled* for all other contact sensing, pulse counting, or demand sync operations.

### Viewing Status Input Conditions

The condition of the status inputs and status input counter totals can be viewed from the front panel using the GROUP buttons (see Section 3.3.2) or via communications. Chapter 4 lists all available status parameters.

### Logging Status Input Conditions

Status input changes can also be logged in the Event Log of the 3720 ACM which is accessible via the communications port. Logging of status input changes can be enabled or disabled via communications.

### Status Input Setpoints

Status input conditions can also be used for setpoints. This allows relay control functions to be performed based on status input conditions. Refer to Chapter 6 for more information.

## 3.9 AUXILIARY VOLTAGE INPUT OPERATION

The 3720 ACM has an auxiliary voltage input (VAUX) which allows an external voltage (1 VAC nominal, 1.25 VAC max.) to be measured and displayed with user-programmable scaling.

Two parameters must be set:

- VAUX SCALE  
This parameter defines what reading is displayed with a 1.000 VAC<sub>RMS</sub> input applied (i.e. full scale input). Range is 0 to 999,999.
- VAUX ZERO  
This parameter defines what reading is displayed with a 0.000 VAC<sub>RMS</sub> input applied. Range is -999,999 to 999,999.

#### EXAMPLE

A transducer is used to measure the operating temperature of a transformer's windings. The output of the transducer is connected to the VAUX input of the 3720 ACM. A transducer output of 1.000 VAC represents 100.0 °C. A transducer output of 0.000 VAC represents 30.0 °C.

Set VAUX SCALE to 100. Set VAUX ZERO to 30.

In this example, a transducer output of 1.000 VAC produces a reading of 100, while an output of 0.000 VAC produces a reading of 30.



**NOTE**

The 3720 ACM does not display VAUX readings with decimal places of resolution; however, additional integer digits of resolution can be obtained by setting both scaling parameters to larger values. For the example above, setting VAUX SCALE to 1000 and VAUX ZERO to 300 provides one more digit of resolution. In this case, remember to interpret the least significant digit as one decimal place (i.e. a reading of 850 is equivalent to 85.0).

### 3.10 AUXILIARY CURRENT OUTPUT OPERATION

The 3720 ACM is equipped with an analog current output (IOUT) that may be programmed to deliver a current proportional to a measured parameter. The maximum load on the current output is 250 ohms resistive. Four parameters must be set:

- **IOUT SCALE**  
This parameter defines the value of the associated measured parameter corresponding to full scale current output. If IOUT KEY = FREQUENCY, IOUT SCALE should be set to the desired parameter value x 100 for which the current output is 20.0 mA. Range is 0 to 999,999.
- **IOUT ZERO**  
This parameter defines the value of the associated measured parameter corresponding to zero scale current output (i.e. the *zero offset*). For an IOUT RANGE value of 0-20 mA, IOUT ZERO should be set to the desired parameter value for which the current output is 0.0 mA. For an IOUT RANGE value of 4-20 mA, IOUT ZERO should be set to the parameter value for which the current output is 4.0 mA. IOUT ZERO can be positive or negative. Range is -999,999 to 999,999.
- **IOUT KEY**  
This defines the measured parameter to which the current output is proportional. Figure 3.4.6b provides a list of measured parameters that may be used.
- **IOUT RANGE**  
This defines the maximum current output range. Choices are 0-20 mA or 4-20 mA.

**EXAMPLE**

The IOUT current output must be proportional to the Phase A current reading. The maximum Phase A current expected is approximately 2000 Amps. The minimum Phase A current expected is approximately 500 Amps. The IOUT output is being used to provide input to a chart recorder with an input range of 4 to 20 mA.

Set IOUT KEY to CURRENT A. Set IOUT RANGE to 4 to 20 mA to match the full input range of the chart recorder. To produce the maximum chart recorder range of deflection, set IOUT SCALE to 2000 and IOUT ZERO to 500.

In this example, a Phase A current input reading of 500 produces 4 mA at the IOUT output (minimum scale deflection of the chart recorder). A Phase A current reading of 2000 produces an output of 20 mA (maximum scale deflection of the chart recorder).

### 3.11 DAYLIGHT SAVINGS TIME

The 3720 ACM supports up to two years of automatic daylight savings time changes (two changes per year). This eliminates the need to manually change the system clock for daylight savings time and ensures that the time stamps accompanying many of the 3720 ACM parameters appear correctly.

**NOTE**

Daylight savings time support is only available via communications.

You can access the daylight savings time setup parameters through POWER MEASUREMENT's SCADA software. The SCADA software provides access to two time changes, or one year's worth. (The other two time changes are available for third party SCADA systems that support four time changes.)

A time change is controlled by the following two variables:

- **TIME OF CHANGE**  
This parameter specifies the date and a daylight savings time period starts or ends. It should be specified in the format  
YY/MM/DD HH:MM:SS  
where MM must be a 15-minute increment (00, 15, 30 or 45) and SS should be 00.
- **CHANGE TO**  
This parameter specifies the new date and time the device's clock should change to when a TIME OF CHANGE occurs. CHANGE TO should be specified using the same format as TIME OF CHANGE.

If the 3720 ACM gets disconnected from the SCADA software, it will still execute the time changes.

**EXAMPLE**

If Daylight Savings starts on April 4 at 2 am and ends on October 30 at 2 am, you need to put your clock one hour forward in the spring, and one hour back in the fall. You can do this using POWER MEASUREMENT's SCADA software by specifying:

```
Time of Change : 95/04/24 2:00:00
Change to      : 95/04/24 3:00:00
Time of Change : 95/10/30 2:00:00
Change to      : 95/10/30 1:00:00
```

## 4 MEASURED PARAMETERS AND STATUS INFORMATION

### 4.1 INTRODUCTION

This chapter provides detailed descriptions of each measured parameter and all status information provided by the 3720 ACM, except for Time-Of-Use registers. TOU is described in detail in Chapter 5.

Parameters are categorized as follows:

#### 1. High-Speed Parameters

#### 2. Real-Time

##### BASE MEASUREMENTS

- Power Parameters
  - voltage
  - current
  - real, reactive, and apparent power
  - frequency
  - power factor
- Harmonic Distortion
  - total, even, odd, individual harmonics
  - K-Factor

##### MEASUREMENT MODES

- Demand
- Minima & Maxima

#### 3. Bi-Directional Energy

##### BASE MEASUREMENTS

- Real, reactive, and apparent energy

##### MEASUREMENT MODES

- Imported, exported, net, and total

#### 4. Status Information

- Control relay conditions, status input conditions, status input counter totals, and setpoint conditions
- Self-diagnostic information

The following sections of this chapter provide complete listing of all measured parameters, their associated display labels, and detailed information on each parameter type.

A complete list of accuracies, display resolutions, and range of readings for all measurements can be found in Appendix D.

### Measured Parameter Display Labels

The large number of measured parameter types and their associated measurement mode combinations requires that the 3720 ACM display parameter names on its front panel using special formats.

The following sections of this chapter illustrate how various parameter types are displayed. As mentioned in Chapter 3, parameter names which require a large number of characters will be presented using the entire display.

### Access to Parameters

All measurements, measurement modes (including user-defined sliding window demands), and status parameters are *continuously* monitored or calculated internally by the 3720 ACM. As described in Chapter 3, you can access a large number of parameters directly from the front panel using the default PHASE, FUNCTION, and GROUP button displays, or by configuring the GROUP buttons to provide access to specific parameters of interest.

The *complete* selection of measured parameters and status information is always accessible via remote communications (Chapter 9).

## 4.2 HIGH-SPEED MEASUREMENTS

A set of high-speed measured parameters are calculated by the 3720 ACM which are true RMS including harmonics, and are updated every two cycles. These parameters are used exclusively as user-definable triggers for the six high-speed setpoints (see Chapter 6), and as parameter options for high-speed snapshot logging. These parameters include:

- Voltage line-to-neutral
  - each phase
  - phase average
- Voltage line-to-line
  - each phase
  - phase average
- Voltage unbalance (%)
- Current
  - each phase
  - phase average
- I4 (neutral or ground current)
- kW (signed value indicates import/export)
  - each phase
  - total of all phases
- kVA
  - each phase
  - total of all phases
- Phase reversal
- Status input condition (S1 to S4, or any)
- Status input counter (S1 to S4)
- Time-overcurrent curve
  - one selected current phase

These parameters are all accessible via communications. Note that most high-speed parameters, except the time-overcurrent curve, are also calculated as real-time (one second update) parameters.

## 4.3 REAL-TIME MEASUREMENTS

Real-time measurements include power parameters and harmonic distortion measurements. The following sections list the *base* (primary) parameters provided, and the additional measurement modes available for each.

### 4.3.1 BASE MEASUREMENTS

#### Power-Related Parameters

These parameters include all voltage, current, power, power factor, and frequency measurements. For phase dependent measurements, this includes per phase readings, and averages or totals for all phases. The I4 (neutral/ground current) and VAUX (auxiliary voltage) inputs are also included. All measurements are true RMS and are updated approximately each second. Figure 4.3.1 lists all measurements and their associated phases or inputs.

#### NOTE

1. Reverse kW or kVAR readings are indicated as a negative value (minus sign).
2. Power factor readings are displayed as leading (PF LD) or lagging (PF LG). See Section 4.5 for polarity conventions.

#### Harmonic Distortion & K-Factor

The 3720 ACM calculates harmonic distortion as a percentage of the fundamental for each of the three phase voltage inputs, the three phase current input channels, the I4 (neutral/ground current) input, and the VAUX (auxiliary voltage) input. For each input the following parameters are calculated:

- Percent total harmonic distortion (THD) up to the 15th harmonic.
- Total even harmonic distortion (TEHD).
- Total odd harmonic distortion (TOHD).
- Harmonic distortion for individual harmonics (HD2 to HD15).

K-Factor (KF) is also calculated using the first 15 harmonics for all eight voltage and current inputs. K-Factor can be useful in the selection of properly rated transformers for application in systems with high harmonic content.

Figure 4.3.1 lists all measurements, their associated phases or inputs, and display labels.

#### CAUTION

The update rate for each harmonic distortion and K-factor parameter is between 5 and 30 seconds. Setpoints programmed to trigger on harmonic distortion parameters can have response times over 30 seconds. Setpoints are described in detail in Chapter 6.

Figure 4.3.1 List of Real-Time Base Measurements &amp; Display Labels

Parameter		Measurements & Display Labels						
Type	Description	Phase or Input <sup>1</sup>						
		A	B	C	Average	Total	I4	Vaux
<b>Voltage</b> <sup>2</sup>	Voltage line-to-neutral (VLN)	A	B	C	*			VX
	Voltage line-to-line (VLL)	A,	B,	C,	*,			
	Voltage unbalance (%)	V UNB						
<b>Current</b> <sup>2</sup>	Current	A	B	C	*		I4	
	Current unbalance (%)	A UNB						
<b>Power</b>	Real power	KW A	KW B	KW C		KW *		
	Reactive power	KVR A	KVR B	KVR C		KVR *		
	Apparent power	KVA A	KVA B	KVA C		KVA *		
<b>Power Factor</b>	Power Factor	PF A	PF B	PF C		PF *		
<b>Frequency</b>	Frequency (phase A)	HZ						
<b>Harmonic Distortion</b> (in percent of fundamental)	Total harmonic distortion (2nd + 3rd + ... 15th)	THD V1	THD V2	THD V3			THD I4	THD VX
		THD I1	THD I2	THD I3				
	Total even harmonic distortion (2nd + 4th + ... 14th)	TEHD V1	TEHD V2	TEHD V3			TEHD I4	TEHD VX
		TEHD I1	TEHD I2	TEHD I3				
	Total odd harmonic distortion (3rd + 5th + ... 15th)	TOHD V1	TOHD V2	TOHD V3			TOHD I4	TOHD VX
		TOHD I1	TOHD I2	TOHD I3				
<b>K-Factor</b>	K-Factor	HDx V1	HDx V2	HDx V3			HDx I4	HDx VX
		HDx I1	HDx I2	HDx I3				

<sup>1</sup> Phase labels are user-definable (see Section 3.6). A comma indicates a *line-to-line* voltage measurement. An asterisk represents *average* of all phases for voltage and current measurements, and *total* for all phases for power and power factor measurements.

<sup>2</sup> Voltage and current readings for individual phases and phase averages are presented on the Volts-Phase-Amps-Function display without additional parameter labels. Normal volt/amp measurements are PT/CT primary measurement. Measurements showing “” are measurements derived from the secondary of the PT/CT (i.e. 120.0 “” indicates 120.0 Volts at the meter inputs).

4.3.2 MEASUREMENT MODES

Additional measurement *modes* available for real-time parameters include thermal demand, sliding window demand, and predicted sliding window demand. Minima and maxima values are also available for all base and demand parameters. Figure 4.3.2a illustrates the modes available to all base parameters, the display labels used to identify them, and examples of combined display labels.

For parameters that have been assigned to the front panel GROUP buttons, additional measurement modes can be accessed using the MODE function described in Section 3.3.2. The sequence of modes available using the MODE function are user-definable, and are dependent on the parameter type.

Demand

INTRODUCTION

Power utilities generally bill commercial customers based on both their energy consumption (in kWh) and their peak usage levels, called *peak demand* (in kW). Demand is a measure of average power consumption over a fixed time period, typically 30 minutes. Peak (or maximum) demand is the highest demand level recorded over the billing period.

Demand measurement methods and intervals vary between power utilities. Some common methods include: thermal averaging, sliding window, and fixed interval techniques. The 3720 ACM can perform demand calculations using both the thermal averaging and sliding window demand techniques. Beyond these methods, the 3720 ACM can also calculate predicted values on all sliding window demand measurements.

NOTE

If the supply power to the 3720 ACM is momentarily disabled, all accumulating thermal, sliding window and predicted demands will be reset to zero. If system demand increases within the same demand period, the 3720 ACM may not sense that a new peak demand has been set. If system demand is maintained at this higher level or increases, a new peak demand will be recorded within the next demand period.

Figure 4.3.2a List of Measurement Modes for Real-Time Parameters

	Base Parameter	Minimum	Maximum
Base Parameter	RT <sup>1</sup>	MN	MX
Thermal Demand	TD	TD.MN	TD.MX
Sliding Window Demand	SD	SD.MN	SD.MX
Predicted Sliding Window Demand	PD	PD.MN	PD.MX

<sup>1</sup> The RT label is not used on the front panel display for base parameters. See the examples below.

Parameter Display Label Examples

Real-time parameter labels and their associated mode labels are combined to produce the displayed parameter name as illustrated in the following examples:

- kW, phase B, real-time ..... KW B
- Power factor, total of all phases, maximum ..... PF \* MAX
- kVA, phase C, thermal demand ..... KVA C TD
- Total odd harmonic distortion, I4 (neutral) input, sliding window demand ..... TOHD I4 SD
- Voltage line-to-line, phase A, predicted s.w. demand, maximum (peak) ..... VLL A, PD.MX

**THERMAL DEMAND**

Thermal demand values are calculated automatically for all base real-time parameters. The 3720 ACM uses a method which is equivalent to thermal averaging. For thermal averaging, the traditional demand indicator responds to heating of a thermal element in a Watt-Hour meter. The thermal demand period is determined by the thermal time constant of the element, typically 15 to 30 minutes.

By default, the 3720 ACM uses base 10 logarithm to calculate the demand curve; this is the characteristic curve used by most utilities. The demand period is the period of time it would take the demand to ramp up to approximately 90% of the steady-state value (see Figure 4.3.2b).

For thermal demand, the programmable demand period is set by the **THERMAL PERIOD** parameter. When you adjust this parameter, the shape of the curve in Figure 4.3.2b changes; this allows you to match the power utility's demand calculation technique.

Another (less popular) method uses the natural logarithm characteristic to calculate the demand curve; the demand period for this curve is the period of time it would take the demand to ramp up to approximately 63% of the steady-state value.

To configure the 3720 ACM to use natural logarithm, you will need to set up the thermal demand characteristic using the PowerView for Windows software.

Each thermal demand measurement also has associated minima/maxima parameters available.

**NOTE**

On the front panel display, thermal demand parameters are indicated using the label **TD**.

**SLIDING WINDOW DEMAND**

The 3720 ACM can provide up to ten sliding window demand measurements. The type of measured parameters that the sliding window values are calculated for are user-programmable via communications. The first four sliding window demand parameters have been programmed into the 3720 ACM at the factory, but you can reprogram them if you wish. These are:

- Current, average of all phases
- kW, total of all phases
- kVAR, total of all phases
- kVA, total of all phases

To compute sliding window demand values, the 3720 ACM uses the *sliding window averaging* (or *rolling interval*) technique which divides the demand interval into sub-periods. The demand is measured electronically based on the average load level over the most recent set of sub-periods. This has the effect of improving the response time as compared to the fixed interval method.

**Figure 4.3.2b Thermal Demand Calculation**

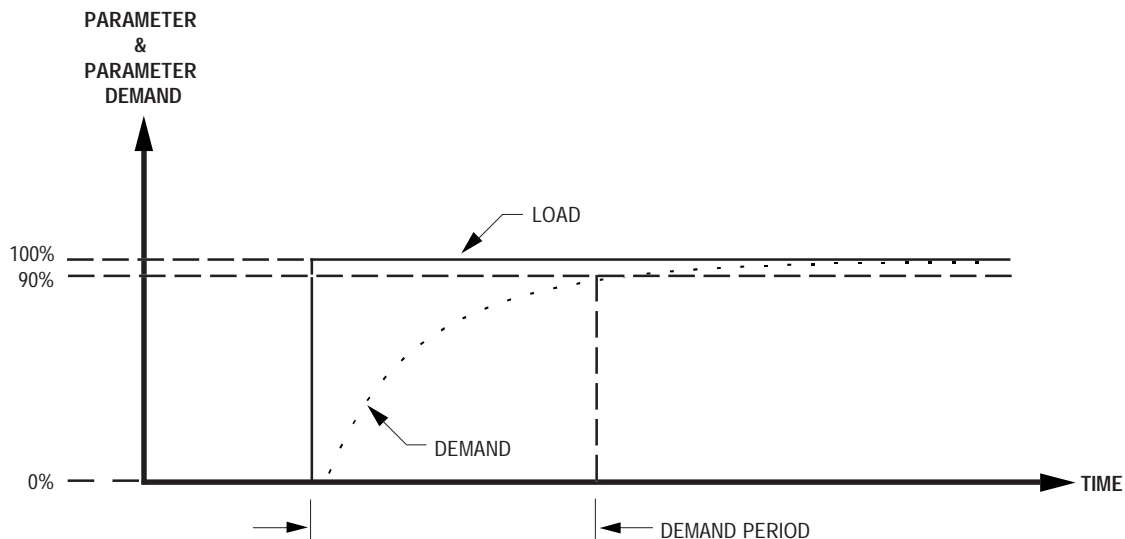




Figure 4.3.2c illustrates how sliding window demand is calculated. The average demand for each of the six previous sub-periods is calculated and these values are averaged across the number of sub-periods (defined by DEMAND PERIOD). In this example, the sliding window demand from 2:00 to 2:05 is  $[(3.0 + 4.3 + 4.5 + 3.1 + 3.9 + 4.7) / 6]$ , or 3.92.

The 3720 ACM allows you to match the power utility's sliding window demand calculation technique. For sliding window measurements, DEMAND PERIOD represents the length of the utility's demand sub-period, while NUM DEMAND PERIOD represents the number of sub-periods which make up the total demand interval. For example, with a 6 x 5 minute (30 minutes total) sliding window method, demand is the average power consumption over the last six 5-minute periods. This allows you to match virtually any type of sliding window measurement method used by the utilities (i.e. 2 x 15 minutes, 6 x 5 minutes, 1 x 30 minutes).

Each sliding window demand measurement also offers minima/maxima parameters.

#### NOTE

1. Using the sliding window method, the 3720 ACM readings will always be as high or slightly higher than the utility readings.
2. On the front panel display, sliding window demand parameters are indicated using the label SD.

#### PREDICTED SLIDING WINDOW DEMAND

The 3720 ACM automatically predicts the value that each sliding window demand parameter will attain when updated at the start of the next sliding demand interval. Additional predicted demand *peak* values can be provided by the Preset and Programmable Min/Max Logs.

The 3720 ACM predicts changes in demand *as they occur*. With predicted demand, the 3720 ACM can be easily applied in energy management strategies. All demand results are available as setpoint triggers which can be used to control any of the on-board relays for load shedding or backup generator control, etc.

The setup parameters DEMAND PERIOD and NUM DEMAND PERIOD used by the sliding window demand calculations are the same for predicted demand. An additional PREDICTED DEMAND BASE parameter sets the sensitivity of the demand prediction, allowing the instrument's response to be carefully tuned to demand variations in the power system. Smaller values provide faster response. The default value is 5%. A value of between 1% and 25% is recommended. Setting to zero disables prediction and returns values of 0 (zero) for all PD parameters.

#### NOTE

On the front panel display, predicted sliding window demand parameters are indicated using the label PD.

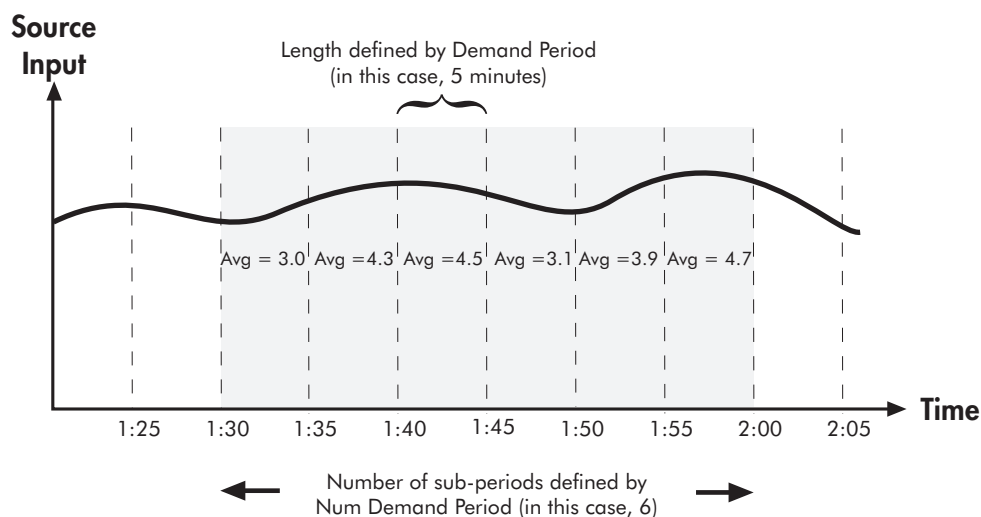
#### EXTERNAL DEMAND SYNCHRONIZATION

When the DEMAND SYN parameter is set to EXTERNAL, the 3720 ACM looks for a pulse (INACTIVE to ACTIVE transition) on status input S4 to indicate the start of the subsequent demand interval. This allows you to synchronize the 3720 ACM demand calculations to the utility's demand period. The NUM DEMAND PERIOD parameter is still operational in this mode and can be used to set the number of sub-periods which make up the total demand interval.

#### INTERNAL DEMAND SYNCHRONIZATION

When the DEMAND SYN parameter is set to INTERNAL, the 3720 ACM times the duration of each demand period using its internal clock.

Figure 4.3.2c Sliding Window Demand Calculation





**RESETTING THE DEMAND PARAMETERS**

The accumulated demand, minimum demand, and maximum (peak) demand measurements are all cleared together when the `CLEAR MIN/MAX?` parameter is set to `YES` in programming mode or via communications. However, all demand measurements are always cleared when any 3720 ACM operating parameter is changed either from the front panel or via communications.

**NOTE**

It is important that any reset of the demand values be performed *near the beginning* of a demand sub-period (synchronized with the utility's sub-period). Resets performed in the middle or near the end of a demand sub-period cause erroneous predicted sliding window demand readings. These occur only for the first one or two sub-periods following the reset. Lower settings for the user-definable `PREDICTED DEMAND BASE` (i.e. < 25%) allow for faster recovery of the predicted demand readings under these circumstances.

**Minima/Maxima**

The 3720 ACM maintains all min/max values in its on-board *Preset Min/Max Log*. This log records the extreme values for all real-time, harmonic distortion, and demand parameters. This includes all user-defined sliding window and predicted sliding window demands.

**NOTE**

On the front panel display, minima and maxima are indicated using `MN` and `MX`, respectively.

**RESETTING MIN / MAX PARAMETERS**

All min/max values in the *Preset Min/Max Log* can be cleared using the `CLEAR MIN/MAX?` parameter from the front panel in programming mode. This also clears the 16 *Program-*

*able Min/Max Logs*. Individual logs can be cleared via communications. This is described in more detail in Chapter 8.

**4.4 ENERGY****4.4.1 BASE MEASUREMENTS**

Energy parameters are *accumulating* values. The base energy parameters include:

- Real energy, or kW hours (kWh)
- Reactive energy, or kVAR hours (kVARh)
- Apparent energy, or kVA hours (kVAh)

All energy parameters represent the *total* for all three phases.

Energy readings are true RMS and are updated approximately once each second. Maximum range of energy readings is 999,999,999. Beyond this value, readings roll over to zero (0).

**4.4.2 MEASUREMENT MODES**

kWh and kVARh energy parameters provide four measurement modes which indicate bi-directional power flow: *imported*, *exported*, *net*, and *total*. The kVAh energy parameter provides only a *net* and a *total* reading, which produce the same result. Figure 4.4.2 illustrates the modes available to each energy parameter, and the display labels used to identify them.

**IMPORTED**

Imported energy represents energy in the positive or forward direction (i.e. energy consumed).

**EXPORTED**

Exported energy represents energy in the negative or reverse direction (i.e. energy generated or fed back to the utility). Readings for imported and exported energy use the labels `IM` and `EX`, respectively.

**NET**

Net measurements represent the difference between energy imported and exported for all three phases. A net export of energy is displayed as a negatively signed number. Net readings are indicated by an `NT` label.

**Figure 4.4.2** List of Measurement Modes for Energy Parameters

Base Parameter	Imported	Exported	Net	Total
kWh (real energy)	KWH* IM	KWH* EX	KWH* NT	KWH*
kVARh (reactive energy)	KVARH* IM	KVARH* EX	KVARH* NT	KVARH*
kVAh (apparent energy)			KVAH* NT	KVAH*

<sup>1</sup> Asterisks following each base parameter label indicate that measurements represent the total of all phases.

**TOTAL**

Total measurements represent the sum of (the absolute values of) the energy imported and exported for all three phases. In other words, a total energy counter increments whether energy is being imported or exported. Total readings do not use any additional mode labels to identify them.

**NOTE**

Conventions used in regards to energy import/export are described in Section 4.5.

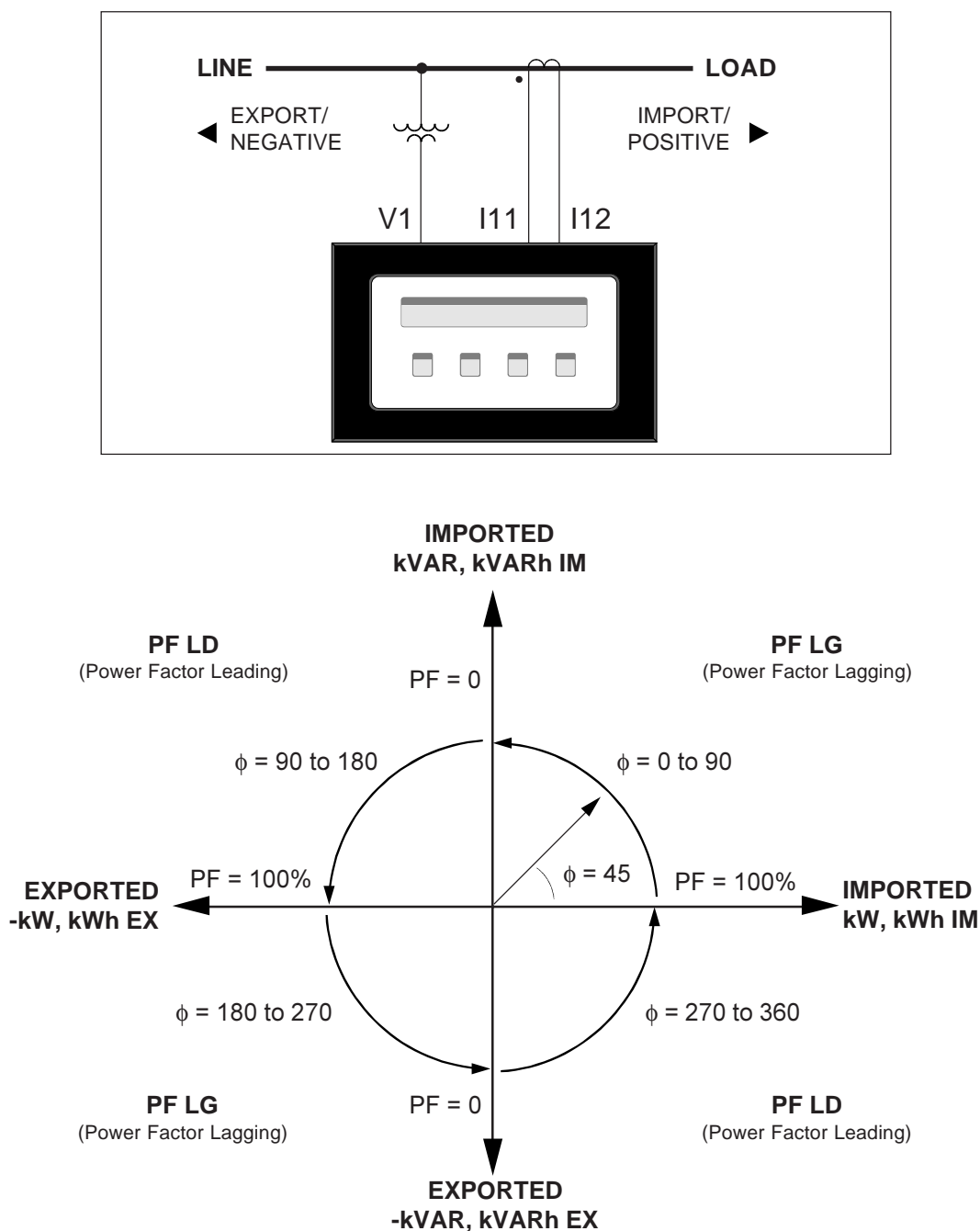
**4.4.3 RESETTING THE ENERGY COUNTERS**

You can reset all kWh, kVARh and kVAh counters to zero (0) using the `CLEAR HOURS?` parameter from the front panel in programming mode, or via communications. This clears the import, export, net, and total counters for each parameter.

**4.5 POWER READING POLARITIES**

Figure 4.5.1 illustrates how the 3720 ACM interprets and displays signed values for power, energy import/export indication, and power factor leading/lagging indication.

**Figure 4.5.1 3720 ACM Power Reading Polarities**



**NOTE**

The polarity of energy import/export readings can be reversed by reversing the polarity of the CTs connected to the 3720 ACM.

## 4.6 STATUS INFORMATION

Status information includes the present conditions of the three on-board relays, four digital (binary) status inputs, four status input counters, and seventeen user-programmable setpoints.

Also included under this category is self-diagnostic information.

This section discusses only the display formats for all status information. Relay and status input operation are described in detail in Chapter 3. Setpoint operation is described in Chapter 6.

### 4.6.1 RELAYS, STATUS INPUTS & SETPOINTS

Figure 4.6.1 illustrates examples of the display label formats used for relay, status input, counter, and setpoint conditions. The 3720 ACM displays relay and status input conditions using the set of default display labels shown. These labels are user-programmable via communications as described in the next section.

## Defining Custom Parameter Labels

Display labels for the active and inactive condition of each relay and status input can be redefined via communications. Labels are limited to 20 alphanumeric characters. Both upper and lower case letters can be defined. Most punctuation can be displayed. Note that all punctuation and spaces are counted as single characters. Delimiters (decimals, brackets, equals sign, etc.) may be defined as part of the label.

### EXAMPLES

BREAKER 82B = TRIP

GENERATOR = ON

POWER MEASUREMENT's SCADA system provides configuration screens for redefining display labels for the 3720 ACM. Labels defined by the system operator are displayed at the computer.

**NOTE**

Display labels for status input counters and setpoints are not user-definable.

### 4.6.2 DIAGNOSTICS PARAMETERS

These parameters are non-programmable, and are used to indicate various internal status conditions of the 3720 ACM. Diagnostic parameters can be accessed in programming mode by setting the DIAGNOSTICS parameter to YES.

Figure 4.6.1 List of Relay, Status Input, and Setpoint Display Labels

TYPE	SOURCE	CONDITION	DISPLAY LABEL
Relay Output	Relay x x = 1, 2, or 3	Released (Inactive)	RELAY x INACTIVE <sup>1</sup>
		Operated (Active)	RELAY x ACTIVE <sup>1</sup>
Status Input	Status Input x x = 1, 2, 3, or 4	Inactive	STATUS x INACTIVE <sup>1</sup>
		Active	STATUS x ACTIVE <sup>1</sup>
Status Input Counter	Status Counter x x = 1, 2, 3, or 4	Accumulated Pulse Count	Sx COUNT = 123456789
Standard Setpoint	Standard Setpoint xx xx = 1 to 11	Inactive	STD Sxx INACTIVE
		Active	STD Sxx ACTIVE
High-Speed Setpoint	High-Speed Setpoint x x = 1 to 6	Inactive	Hx INACTIVE
		Active	Hx ACTIVE

<sup>1</sup> The inactive and active state labels for status inputs and relays are user-definable via communications.

<sup>2</sup> M-SCADA / L-SCADA displays default standard and high-speed setpoint labels as Sxx INACTIVE/ACTIVE, and Hx INACTIVE/ACTIVE.

Firmware Version

This indicates the current firmware version installed in the 3720 ACM. Figure 3.4.6d in Chapter 3 describes the format of firmware version numbers.

Through its policy of ongoing product development, POWER MEASUREMENT may offer firmware upgrades for the 3720 ACM in the future. These might offer additional features or expand existing functionality. You can view the current 3720 ACM firmware number to ensure that the meter is equipped with the latest revision of firmware available, or if an upgrade is required.

Extended Diagnostics Parameters

The 3720 ACM provides three groups of *extended* diagnostics parameters. Figure 4.6.2 lists all extended parameters. These parameters can be used as follows:

GROUP 1: COMMUNICATIONS

This group of parameters can be useful to third-party developers requiring real-time remote communications diagnostics information. Refer to the *3720 ACM Communications Protocol* document for more detailed descriptions of these parameters.

GROUP 2: BATTERIES

These parameters indicate the current condition of the two on-board backup batteries. Low levels indicate that

remaining battery life is limited and that one or both of the batteries should be replaced.

GROUP 3: METER TIME

This parameter can be used to view the current date and time indicated by the meter's on-board clock. Note that these can be reset via communications only.

To access the extended diagnostics parameters, use the following procedure:

- 1. Enter programming mode and set the EXTENDED parameter (under DIAGNOSTICS) to YES.
- 2. Return to display mode.
- 3. Access the extended parameters by pressing the PHASE and FUNCTION buttons at the same time. The first group that appears is COMMUNICATIONS.
- 4. Use the PHASE button to advance through each parameter in the group (see Figure 3.11.1). The list wraps around.
- 5. Press PHASE and FUNCTION together to advance to the next group. The list groups wraps around.
- 6. Press FUNCTION to return to normal display mode.

You can continue to access the extended parameters as described above if the EXTENDED parameter remains set to YES.

Figure 4.6.2 Extended Diagnostics Parameters

Group 1: Communications		
RX FRAME	# of any 3720 ACM frames detected on the bus	Total increments by 1
TX FRAME	Frames transmitted	Total increments by 1
NO RESPONSE	Application layer not ready	If true, total increments by 1
BAD CHECKSUM	Bad CRC-16	If true, total increments by 1
INCOMPLETE	Reserved for future use	
WATCHDOG	No 3720 ACM frames detected on the bus for a period exceeding 5 minutes	If true, total increments by 1
BYTE ERROR	Framing errors (indicates data collisions)	Total increments by 1
OVERRUN	Data received at too high a rate	If true, total increments by 1
Group 2: Batteries		
RTC	Real-Time Clock battery life remaining (% of max)	0 to 100
RAM	NVRAM battery life remaining (% of max).	0 to 100
Group 3: Meter Time		
WWW MMM DD HH:MM:SS	Real-Time Clock date and time	WWW = MON • TUE • WED • THU • FRI • SAT • SUN MMM = JAN • FEB • MAR • APR • MAY • JUN • JUL • AUG • SEP • OCT • NOV • DEC DD = 1 to 31 HH = 0 to 23 MM = 0 to 59 SS = 0 to 59

Pressing PHASE + FUNCTION advances through each group and returns to the display mode.  
Pressing PHASE advances through each parameter within a group.

## 5 TIME-OF-USE SYSTEM

### 5.1 INTRODUCTION

Time of Use (TOU) is a billing scheme that uses a varying tariff structure that depends on the time of day. In general, power is more expensive during peak periods than in non-peak periods to encourage customers to transfer usage to off hours. The tariff structure may be quite complex, taking into account the time of day, the day of the week, the seasons, and holidays.

The TOU feature in the 3720 ACM can be used to record energy usage and demand for virtually any tariff structure. The 3720 ACM records energy usage in a set of three accumulating energy registers and three demand registers for each of up to ten tariffs. The meter determines the tariff for a given time and date through an internal calendar.

### 5.2 PROGRAMMING

#### 5.2.1 POWERVIEW

POWER MEASUREMENT's PC Windows-based PowerView for Windows program is required to configure the TOU capability in the 3720 ACM. Any compatible third-party software can also be used. PowerView provides a smart and simple way to program all aspects of the TOU system, as well as some basic cost calculations from the data collected by the 3720 ACM.

To set up the TOU system, select the 3720 ACM icon from the left pane of PowerView, and then double-click the Time of Use icon on the right pane.

#### 5.2.2 RATES AND TARIFFS TAB

Ten tariffs can be specified in the Rates and Tariffs tab. Each can be assigned to one or more daily profiles.

A 24-hour clock (with a resolution of 15 minutes) is used to specify the daily start time for each tariff. One of the 10 tariffs can also be configured as the penalty tariff. An active level on the 3720 ACM Status Input S3 (i.e. from the power utility) automatically activates the penalty tariff.

The following controls are available in the Rates and Tariffs tab:

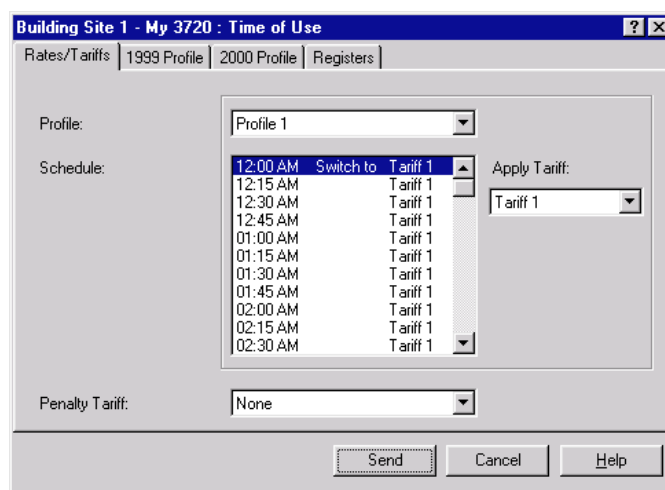
**Profile:** This is used for selecting a profile to be edited. There is a maximum of 16 daily tariff profiles available. Each profile supports a maximum of 8 tariff changes per day. Profiles are explained in the next section.

**Schedule:** This is used for selecting what the time(s) of day a defined tariff should be applied. Hold the Shift or Ctrl key while clicking the mouse to select multiple blocks of time.

**Apply Tariff:** This is used to select which tariff will be applied to the selected time(s) of day. There are 10 available tariffs, one of which can be defined as the penalty tariff.

**Penalty Tariff:** This is used to select which of the 10 available tariffs is to be defined as the penalty tariff.

Figure 5.2.2 Rates/Tariffs Tab



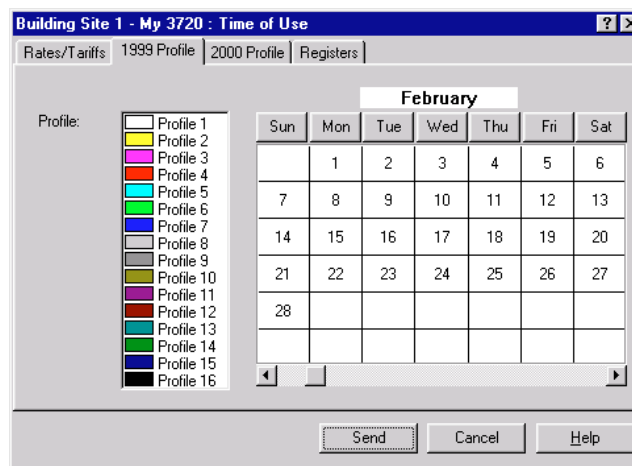
#### 5.2.3 PROFILES TAB

There are two Profiles tabs. They provide monthly calendars for the current year and the next.

One of the 16 tariff profiles can be applied to any day, or to groups of days (e.g. weekdays, weekends, etc) in the calendars.

To apply a tariff, first select one of the 16 profiles. Then, click the date when that profile will be applied. The Sun to Sat buttons are used for applying the profile to all selected days in that month (e.g. click the Mon button to apply the profile to all Mondays in that month). Use the left or right arrow buttons on the scroll bar to move to the previous or next month, respectively.

Figure 5.2.3 Profiles Tab



### 5.2.4 REGISTERS TAB

Each tariff contains two groups of registers to record TOU data: Demand Registers and Energy Registers.

Three demand registers record the peak demand during each defined tariff period since the last time the registers were reset. The registers can record peak kW, kVAR, kVA or Current Average, and may be computed using the sliding window averaging or thermal demand technique. Note that these measurements are unique to the TOU system, and are separate from the demand parameters the 3720 ACM provide for real-time, setpoint, and logging functions.

Demand register calculations are performed based on the setup parameters DEMAND PERIOD and NUM DEMAND PERIOD. Refer to Section 4.3.2 for more information.

Three energy registers accumulate the power flow during each defined tariff period since the last time the registers were reset. The energy registers may be configured to accumulate kWh, kVARh or kVAh, qualified by Net, Import, Export or Total.

Figure 5.2.4 Registers Tab

### 5.2.5 STATUS PARAMETERS

The 3720 ACM provides two additional status parameters, which indicate the currently *Active Profile* and *Active Tariff*. These parameters can be programmed to be displayed on the front panel, using the Group Keys setup screen in PowerView.

## 5.3 ACCESS TO TOU DATA

### 5.3.1 READING TOU DATA

The real-time value of each TOU energy and demand register, and the condition of the Active Profile and Active Tariff status parameters can be read from the 3720 ACM front panel (through GROUP button assignments), or via communications using POWER MEASUREMENT's PowerView for Windows software, or any compatible third-party software.

All TOU register data and status parameter conditions can also be logged in 3720 ACM Min/Max or Snapshot Logs, and archived to the ODBC-compliant database provided by the PowerView for Windows software.

### 5.3.2 USING TOU DATA AS TRIGGER PARAMETERS

Energy registers, demand registers, and status parameters can be assigned as trigger parameters for the Programmable Min/Max logs or triggers for standard setpoints.

### 5.3.3 RESETTING THE TOU REGISTERS

Energy and demand registers can be synchronously cleared together manually via communications, or automatically using standard setpoints.

Using setpoints, the registers can be reset on a hourly, daily, weekly, monthly or yearly basis. TOU data can be stored to a Snapshot Log prior to reset, if desired. This is described in Section 6.4.6.

#### NOTE

TOU Energy registers and demand registers can be cleared from the front panel using the Clear Hours, and Clear Max/Min options from the Clear Functions menu.

## 5.4 CALCULATION OF ENERGY COSTS

Using PowerView for Windows, a per-unit cost can be defined for energy and for demand for each of the 10 tariffs.

The TOU data can be copied and pasted into a spreadsheet application such as Microsoft Excel. The figures can then be used for calculating a simple cost based on the accumulated energy or demand values.



## 6 SETPOINT SYSTEM

### 6.1 INTRODUCTION

The 3720 ACM user-programmable setpoint system provides a host of control, protection, and analysis tools. Setpoints provide extensive control over the three on-board relay outputs, as well as triggering capabilities for the waveform capture, waveform recording and snapshot logging features. Seventeen individual setpoints are provided, six of which offer *high-speed* capabilities.

Setpoint-controlled relays can be used to perform such functions as automated demand, power factor, or voltage control. Setpoints can also enhance system reliability and safety by protecting against such conditions as neutral current or transformer heating, and ground current leakage. Upon the detection of a fault condition, the on-board relays can be used to activate external alarms or to provide *shadow* protection on critical breakers. Fault conditions can be analyzed in detail to determine their source(s) using sampled waveform data or logged data triggered by user-defined setpoint levels.

#### Programmability

A group of programmable parameters specify how a setpoint is to operate. These parameters are programmable via communications only:

- The **TRIGGER** parameter defines the parameter a setpoint is to monitor. This can be a measured parameter, status input condition, etc.
- Two setpoint *limits* are provided (**HIGH LIMIT**, **LOW LIMIT**). One of these limits defines the value of the trigger parameter which will activate the setpoint. The other limit defines the value of the trigger parameter which will deactivate the setpoint.
- Setpoint *actions* define the operations that each setpoint can be used to control. When a setpoint becomes active it can be used to trigger relay control, waveform capture, waveform recording, snapshot logging, or a number of different register clearing operations (i.e. Min/Max Log, status input counters, TOU registers). Each setpoint can control up to two independent actions simultaneously. If you want only to log a setpoint condition when it occurs, the setpoint can also be programmed to perform no subsequent actions.
- Two programmable time delays are provided: **TIME DELAY TO OPERATE** and **TIME DELAY TO RELEASE**. The function of these time delays is described in Sections 6.3.2 and 6.2.3.

#### Applications Flexibility

Setpoint programming has been made extremely flexible to facilitate a wide range of alarm, control, and analysis applications. Each of the seventeen setpoints can be programmed to concurrently monitor a separate parameter. A single active setpoint can trigger up to two independent actions (relay control, logging, etc.) For multi-level control, more than one setpoint can monitor the same parameter. Multiple setpoints can also be assigned to trigger the same action (i.e. "OR" function). Figure 6.1.1 illustrates the wide range of setpoint capabilities.

#### Event Logging

All setpoint activation and deactivation conditions are automatically recorded in the on-board Event Log. This includes any setpoints which become activated, but are not programmed to perform any subsequent setpoint actions (relay control, etc.)

Event Log entries include the date and time stamp that indicates when the setpoint event occurred, and the value of the trigger parameter. Any subsequent setpoint action will also be displayed in the log, along with a date and time stamp. The Event Log is described in more detail in Chapter 7.

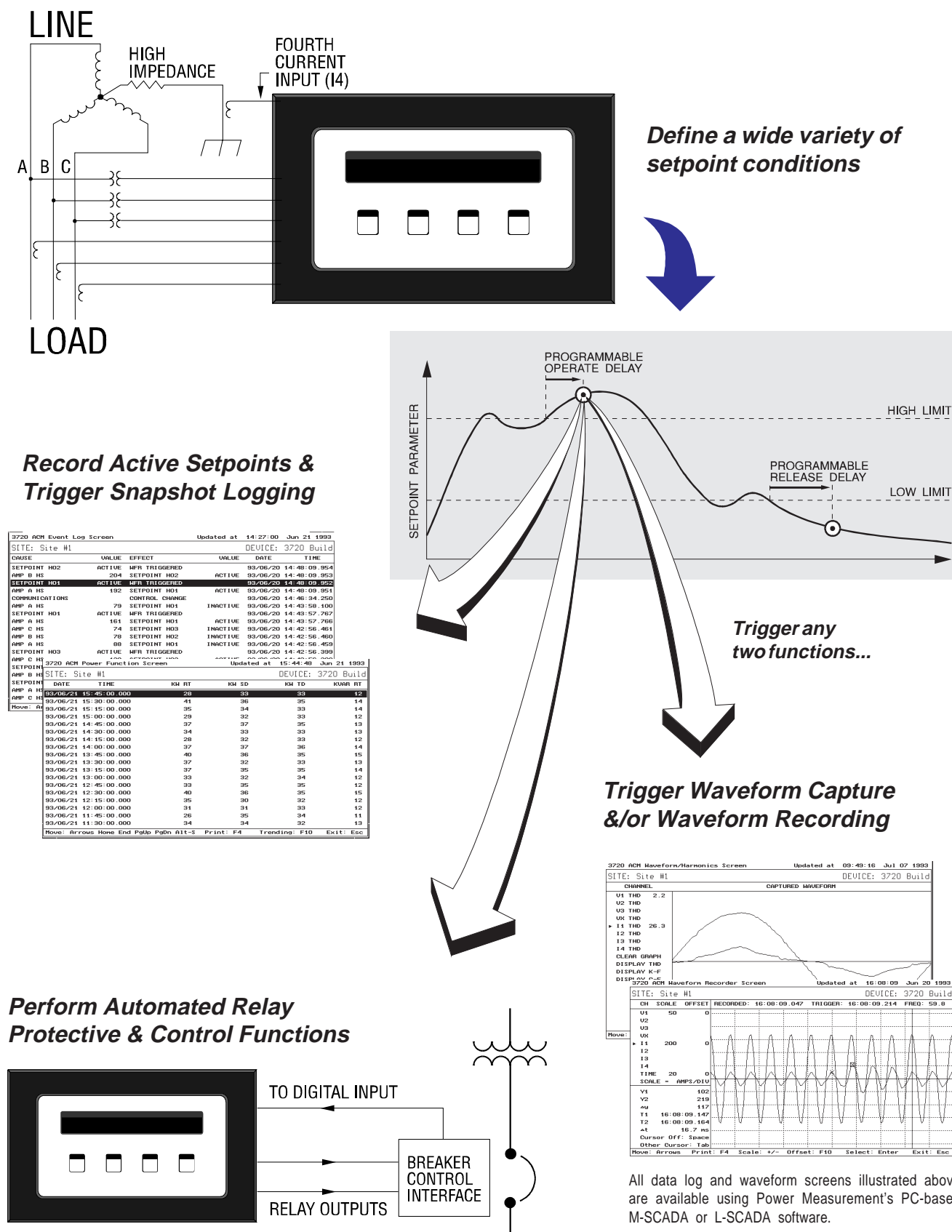
#### High Reliability

Monitoring of all setpoint conditions is performed continuously by the 3720 ACM, uninterrupted by the execution of other on-board measurement, control or logging operations. This means that critical setpoint-related events of short duration are always captured.

The following sections describe setpoint operation and programming in detail.



Figure 6.1.1 Setpoint Capabilities



## 6.2 SETPOINT TYPES

### 6.2.1 INTRODUCTION

The 3720 ACM offers six *high-speed* setpoints and eleven *standard* setpoints. Both setpoint types are similar in their operation and programmability; however response times for each differ significantly. The characteristic response of each setpoint type makes each ideal for specific ranges of applications.

### 6.2.2 SETPOINT RESPONSE TIMES

#### Time Specifications

Due to the difference in response characteristics between *high-speed* and *standard* setpoints, the response times and programmable delays for each are specified using different units. High-speed setpoint\* times are specified in *number of cycles* (where a cycle = 16.6 ms for a 60 Hz input, or 20 ms for a 50 Hz input). Standard setpoint times are specified in *number of seconds*.

#### Normal Operation Response

Under normal operating conditions, the response time of setpoint functions is defined as the time lapse between a setpoint *event* occurring and an associated setpoint *action* being executed. Response times are as follows:

#### HIGH-SPEED SETPOINT

3 cycles (typical), 4 cycles (maximum).

#### STANDARD SETPOINTS

1 second (typical), 2 seconds (maximum). This does not include harmonic distortion parameters (see CAUTION note below).

#### CAUTION

1. The update rate for each harmonic distortion parameter is between 5 and 30 seconds. Setpoints programmed to trigger on harmonic distortion parameters can have response times over 30 seconds.
2. The 3720 ACM on-board relays have a response time of 8 milliseconds (typical), 15 milliseconds (maximum). This does not include any additional contact bounce which may occur. This response must be added to setpoint response times when using setpoints to trigger relay control actions.

### Power Up Response

For both high-speed and standard setpoints, response time could be up to 5 seconds after any meter power up (i.e. initial power or subsequent power ups following any system power failures). The 3720 ACM should not be used for protective functions which require faster operation. A battery-backed DC power supply should be considered for 3720 ACM devices whose setpoints are being used perform protective functions where response time is important.

### 6.2.3 HIGH-SPEED SETPOINTS

The six *high-speed* setpoints are numbered H01 to H06. High-speed setpoints are ideally suited for conditions where fast response is essential, such as over current or voltage, reverse power, or ground faults on high impedance ground systems.

#### CAUTION

The 3720 ACM is not intended for use as a primary overcurrent protection device. Setpoint relay control capabilities are designed to execute a variety of less critical functions, or to perform shadow (backup) protection on critical breakers.

The setpoint *trigger* parameters that can be used with the high-speed setpoints are listed in Figure 6.3.1a. The measured parameters associated with these trigger parameters are the internal *high-speed* parameters described in Chapter 4.

### 6.2.4 STANDARD SETPOINTS

The eleven *standard* setpoints are numbered S01 to S11. Standard setpoints are ideally suited for a wide range of operations ranging from simple alarm activations to fully automated demand, power factor, or load control.

The setpoint *trigger* parameters that can be used with the standard setpoints are listed in Figure 6.3.1b. The measured parameters associated with these trigger parameters are the *real-time* and *harmonics* parameters described in Chapter 4.

## 6.3 TRIGGER PARAMETERS

### 6.3.1 INTRODUCTION

Figure 6.3.1 lists all trigger parameters, including parameters that can only be used with the six *high-speed* setpoints and parameters that can be used with the eleven *standard* setpoints.

This section describes the characteristics of various types of trigger parameters in detail.

**Figure 6.3.1 Setpoint Trigger Parameters****HIGH-SPEED SETPOINT TRIGGER PARAMETERS**

PARAMETER	DESCRIPTION
NOT USED	Disables the setpoint.
OVER V <sup>1</sup>	Active if measured voltage exceeds specified value, for selected phase or phase average.
UNDER V <sup>1</sup>	Active if measured voltage falls below specified value, for selected phase or phase average.
V IMBAL	Active if measured value for any voltage phase differs from the measured phase average by the specified percent (%) value.
OVER AMP	Active if measured current exceeds specified value, for selected phase or phase average.
UNDER AMP	Active if measured current exceeds specified value, for selected phase or phase average.
OVER I4	Active if measured I4 (neutral) current exceeds specified value.
OVER KW IMP <sup>2</sup>	Active if measured kW imported exceeds specified value, for selected phase or phase total.
OVER KW EXP <sup>2</sup>	Active if measured kW exported exceeds specified value, for selected phase or phase total.
OVER KVA <sup>2</sup>	Active if measured kW exported exceeds specified value, for selected phase or phase total.
OVER FREQUENCY	Active if measured frequency exceeds specified value.
UNDER FREQUENCY	Active if measured frequency falls below specified value.
TOC	Response based on user-programmable time-overcurrent curve, for selected phase or phase average (see Section 6.3.4).
PHASE REVERSAL <sup>4</sup>	Active if the actual phase rotation does not match the programmable PHASE ROTATION parameter.
STATUS x OFF	Active if status input Sx becomes inactive (x = 1 to 4).
STATUS x ON	Active if status input Sx becomes active (x = 1 to 4).
ANY STATUS OFF	Active if any status input becomes inactive.
ANY STATUS ON	Active if any status input becomes active.
Sx COUNTER	Active if status input Sx counter total exceeds specified limit (x = 1 to 4) .

**STANDARD SETPOINT TRIGGER PARAMETERS**

PARAMETER	DESCRIPTION
NOT USED	Disables the setpoint.
OVER <parameter> <sup>3</sup>	Active if measured value for the selected parameter exceeds specified value. Parameters options include all real-time, harmonics, demand, and min/max measurements for all applicable phases, phase averages, phase totals, I4 or Vaux inputs. A total of over 700 parameter options are provided.
UNDER <parameter> <sup>3</sup>	Active if measured value for the selected parameter falls below specified value. Parameters options are similar to OVER setpoint described above.
V IMBAL	See High-Speed section above.
A IMBAL	Active if measured value for any current phase differs from the measured phase average by the specified percent (%) value.
PHASE REVERSAL <sup>4</sup>	See High-Speed section above.
STATUS x OFF	Active if status input Sx becomes inactive (x = 1 to 4).
STATUS x ON	Active if status input Sx becomes active (x = 1 to 4).
ANY STATUS OFF	Active if any status input becomes inactive.
ANY STATUS ON	Active if any status input becomes active.
Sx COUNTER	Active if status input Sx counter total exceeds the specified limit (x = 1 to 4).
NEW xxxx	Momentarily active when real-time clock advances to a new hour, day, week, month, or year (xxxx = HOUR, DAY, WEEK, MONTH, or YEAR).

**NOTES**

- <sup>1</sup> Volts line-to-line not functional if Volts Mode = Wye. Volts line-to-neutral not functional if Volts Mode = Delta. In single phase mode, Vc, Ic, Vbc and Vca are not available.
- <sup>2</sup> Per phase measurements are not available for OVER KW IMP, OVER KW EXP, or OVER KVA if Volts Mode = Delta. In single phase mode, phase C power measurements are not available.
- <sup>3</sup> Volts line-to-neutral not functional if Volts Mode = Delta. Per phase kW, kVAR, and kVA options not available if Volts Mode = Delta.
- <sup>4</sup> Not functional if Volts Mode = Single or 3W-WYE.

### 6.3.2 OVER & UNDER SETPOINTS WITH TIME DELAYS

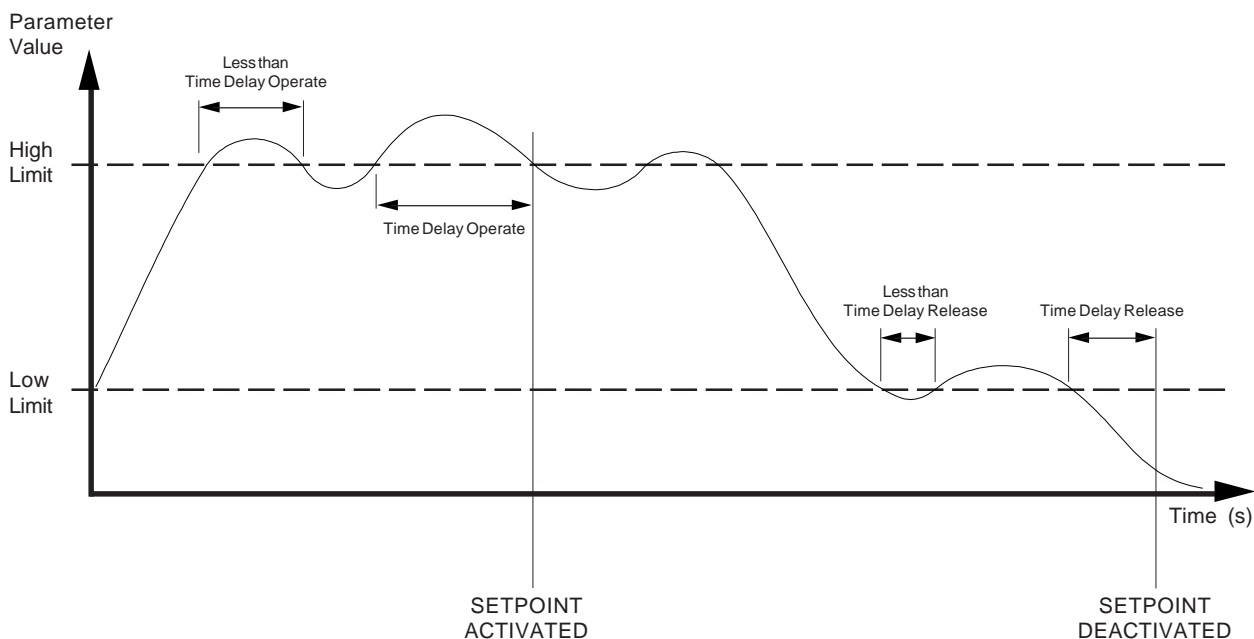
Many trigger parameters can function either as an *over* setpoint (i.e. *over current*) or an *under* setpoint (i.e. *under voltage*).

#### Over Setpoint

Figure 6.3.2a illustrates the operation of an *over* setpoint. An over setpoint becomes active when the parameter that is being monitored exceeds and remains over the value of the programmable HIGH LIMIT parameter for a time greater than the value of the TIME DELAY TO OPERATE parameter.

An over setpoint becomes inactive when the trigger parameter that is being monitored falls below the value of the LOW LIMIT parameter for a time greater than the value of the TIME DELAY TO RELEASE parameter. The differential between the high and low limits effectively produces a programmable level of operational *hysteresis* (or *deadband*).

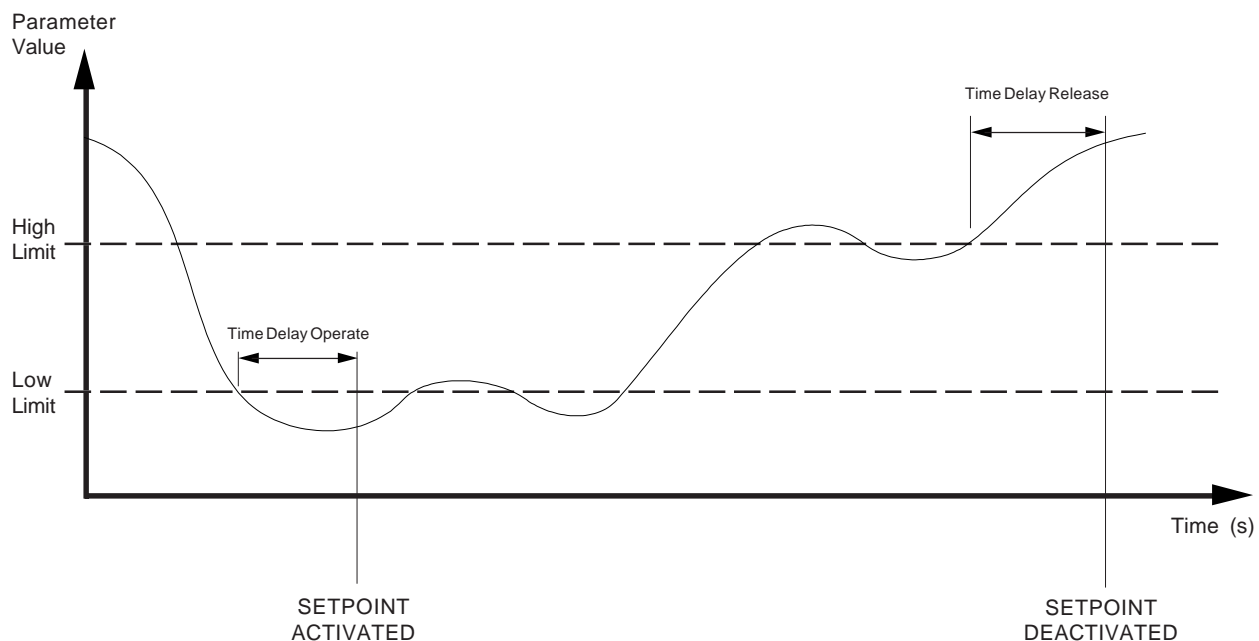
Figure 6.3.2a Over Setpoint Operation



## Under Setpoint

Figure 6.3.2b illustrates the operation of an *under* setpoint. An under setpoint differs only in that the meanings of high limit and low limit are reversed. The setpoint becomes active when the trigger parameter falls below the value of the LO LIMIT parameter for a time greater than the value of the TIME DELAY TO OPERATE parameter. The under setpoint becomes inactive when the parameter exceeds and remains over the value of the HIGH LIMIT parameter for a time greater than the value of the TIME DELAY TO RELEASE parameter. Similar to over setpoint operation, the differential between the high and low limits produces an area of hysteresis.

Figure 6.3.2b Under Setpoint Operation



6.3.3 ON/OFF & COUNTER SETPOINTS

Some trigger parameters provide a simple *on* or *off* condition, such as phase reversal, or status input conditions. For status input types, setpoints can monitor the condition of individual inputs (i.e. s1 ACTIVE, s2 NORMAL, etc.) or monitor all four status inputs together (i.e. sx ACTIVE). This second method effectively operates as a Boolean “OR” function. For all on/off trigger parameters, the setpoint will become active when the defined condition becomes true. These trigger parameters do not use the HIGH or LOW LIMIT parameters.

Setpoints can also monitor status input counter totals. The setpoint will become active when the associated counter exceeds the total defined by the HIGH LIMIT parameter. These trigger parameters do not use the LOW LIMIT parameter.

6.3.4 TIME-OVERCURRENT CURVE

NOTE

The Time-Overcurrent Curve (TOC) cannot be used concurrently with the High-Speed Snapshot Log (HSS) feature. You must select which feature to enable by setting the HIGH SPEED FEATURE parameter via communications. To enable the Time-Overcurrent Curve, set it to TOC.

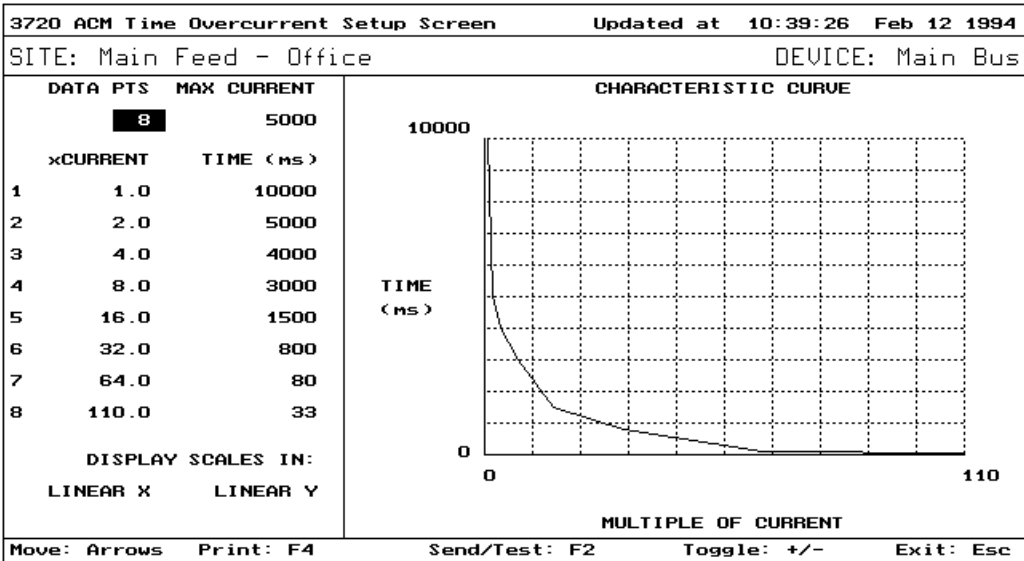
The 3720 ACM offers additional overcurrent protection capabilities using a programmable inverse time characteristic. Only the six high-speed setpoints can use this setpoint type. Virtually any time-current characteristic can be defined to match a wide range of applications.

The time-overcurrent curve represents a boundary for safe current operation of a feeder. The curve is represented by current on the x-axis and time on the y-axis. The curve’s shape is such that as the current increases, the time necessary to trip the setpoint is reduced (see Figure 6.3.4). The amount of time required to trip the setpoint is configurable through selection of the proper data points.

NOTE

For accurate time-overcurrent response times, the meter must provide adequate current over-range capability to measure the expected peak current. To provide this, the meter must be equipped with the correct over-range option (i.e. XAMPS, YAMPS, or ZAMPS). See Section 2.5.2.

Figure 6.3.4 Time-Overcurrent Curve



## Setpoint Active Condition

The time-overcurrent setpoint operates similar to all other setpoints. If the 3720 ACM measures a current that is maintained for a period of time longer than is specified on the characteristic curve, the setpoint becomes active. This curve is based on TIME versus XCURRENT multiplied by the MAX CURRENT (or *pickup* current). For example, in Figure 6.3.4 if the current becomes:

$$\begin{aligned} & \text{XCURRENT} \times \text{MAX CURRENT} \\ &= 2.0 \times 5000 = 10,000 \text{ Amps} \end{aligned}$$

the setpoint would take 5000 milliseconds to become active.

### NOTE

Time-overcurrent calculations are based on the high-speed setpoint system which provides response times in increments of 2 cycles. Refer to Section 6.2.2 for minimum response times.

## Setpoint Inactive Condition

An inverse version of the time-overcurrent curve is used to determine when the setpoint becomes *inactive*. This curve is based on TIME versus the MAX CURRENT divided by the XCURRENT. For example, in Figure 6.3.4 if the current fell to:

$$\begin{aligned} & \text{MAX CURRENT} / \text{XCURRENT} \\ &= 5000 / 2.0 = 2500 \text{ Amps} \end{aligned}$$

the setpoint would take 5000 milliseconds to become inactive.

## Additional Time Delays

The programmable TIME DELAY TO OPERATE and RELEASE delays are still operational for this setpoint type; however, it is not recommended that they be used. Required delays should be implemented using the characteristic time delays of the time-overcurrent curve. Using the TIME DELAY TO OPERATE and RELEASE parameters to provide additional delays could produce unexpected results.

## Programming

You can program response curve parameters via the communications port. POWER MEASUREMENT's SCADA system provides a setup screen for the time-overcurrent curve. Specify the MAX CURRENT parameter, then define the eight data points on the curve using the y-axis coordinate XCURRENT and the x-axis coordinate TIME parameters. Once the curve has been calculated and displayed, it can be sent to the 3720 ACM via communications and stored. To define a high-speed setpoint as a time-overcurrent type, set its TYPE parameter to TIME OVERCURRENT.

## 6.4 SETPOINT ACTIONS

### 6.4.1 INTRODUCTION

#### Action 1 & Action2

An active setpoint condition can be used to simultaneously trigger up to two separate actions. Each setpoint has two programmable parameters which allow you to define each action. These are named ACTION1 and ACTION2.

### NOTE

If ACTION1 and ACTION2 are both configured for a setpoint, ACTION1 is always performed *first*.

#### Action Types

For each setpoint action, many action types are available.

The eleven *standard* setpoints can be used to trigger:

- Relay control
- Waveform capture
- Waveform recording
- Snapshot logging (standard only)
- Clearing functions:
  - clearing the Min/Max Logs (preset and/or programmable)
  - clearing the status counters (one or all)
  - resetting the TOU energy registers and/or TOU demand registers.

The six *high-speed* setpoints can trigger:

- Relay control
- Waveform capture
- Waveform recording
- Snapshot logging (high-speed only)
- Clearing functions:
  - clearing the status counters (one or all).

#### Programming

ACTION1 and ACTION2 for each setpoint are both programmable via communications. The following sections describe each setpoint action in detail.



### 6.4.2 RELAY CONTROL

Any of the three on-board relays of the 3720 ACM can be automatically controlled by a high-speed or standard setpoint. Setpoint-controlled relays can perform a wide range of operations, including:

- Shunt tripping a breaker
- Activating an alarm buzzer or light
- Controlling an external piece of equipment.

#### NOTE

Refer to Sections 6.2.2 and 6.2.3 for information regarding setpoint and relay response times and other considerations.

A relay assigned to a setpoint is automatically operated when the setpoint becomes active, and released when the setpoint returns to its inactive state.

#### Programming

To configure a setpoint for relay control, you must program the parameters for both the setpoint and for the assigned relay:

- Set the ACTION1 or ACTION2 parameter to the desired relay.
- The MODE parameter for the assigned relay must be defined as SETPOINT.

The programmable TIME DELAY TO OPERATE delay can be used to delay a setpoint from becoming active, thus delaying when the assigned relay is operated. The programmable TIME DELAY TO RELEASE delay can be used to delay when the setpoint returns to its inactive state, thus delaying when the assigned relay is released.

#### Avoiding Operational Conflicts

As described in Chapter 3, relays may also be used for kWH, kVARH, or kVAH pulsing. Take care that a relay configured for hour pulsing is not also assigned to setpoint operation. Pulsing operations always override setpoint control.

#### Multi-Level and Multi-Function Relay Control

The 3720 ACM setpoint system allows for multi-level and multi-function relay control operations. The following examples illustrate this flexibility.

#### EXAMPLES

1. By assigning the same relay number to more than one setpoint, multiple setpoints can be channelled to a single relay. This feature can effectively produce a Boolean “OR” function. This also allows a single relay to perform multiple functions; however, as mentioned above, care must be taken to avoid operational conflicts.
2. You wish to configure a two-level relay protection scheme. First assign two setpoints to monitor the same trigger parameter (i.e. OVER CURRENT). Set each setpoint to trigger on a different parameter limit, one higher than the other (i.e. H01 HI LIMIT = 500, H02 HI LIMIT = 750). Configure each setpoint to control a different relay (i.e. H01 ACTION1 = RELAY1, H02 ACTION1 = RELAY2). Each relay could control a different external protection device. As the value of the measured parameter increases, each relay will trip in sequence.

#### Manual Forced Relay Override

A relay configured for setpoint control (MODE = SETPOINT) may be forced operated or released using commands issued via communications. Manual commands override any present setpoint-controlled relay operations. Once a command to *return to normal* is issued via communications, the affected relay is immediately returned to setpoint control.

### 6.4.3 WAVEFORM CAPTURE TRIGGERING

Any of the standard or high-speed setpoints can be used to trigger the waveform capture functions. Setpoint triggered waveform capture allows the 3720 ACM to automatically perform a high-resolution capture of one cycle of a single selected input. Input options include any one of the six phase voltage and current inputs, I4 (neutral) input, or Vaux input. This data can be uploaded to POWER MEASUREMENT'S SCADA software to facilitate analysis of the harmonic content which existed coincident with the fault condition defined by the setpoint. This is described in more detail in Chapter 6.

#### Programming

To configure a setpoint condition to trigger waveform capture, the user must program one of the setpoint's two ACTION parameters as WAVE CAPTURE xx, where xx represents the specific input to be captured (V1, I1, etc.)

The programmable TIME DELAY TO OPERATE delay can be used to provide a delay interval between when the setpoint becomes active and when waveform capture is triggered. The TIME DELAY TO RELEASE parameter has no effect.

#### Manual Trigger Override

A waveform capture trigger command received via communications overrides any setpoint controlled waveform capture action. Once the capture data has been uploaded via communications, the recorder automatically re-arms and returns to setpoint control.

#### 6.4.4 WAVEFORM RECORDER TRIGGERING

Any of the standard or high-speed setpoints can be used to trigger the waveform recording function. Waveform recording can provide a detailed 12 to 36-cycle record of all input signals before, during, and after the occurrence of a fault. Inputs include all six phase voltage and current inputs, plus the I4 (neutral) and VAUX inputs.

The recorder can be configured to store three 12-cycle events, two 18-cycle events, or one 36-cycle event on-board for all inputs. The waveform recorder runs continuously until it is triggered either by a setpoint event or manually by a command issued via communications. At that time the waveform data is frozen in memory. This is described in more detail in Chapter 7.

##### Programming

To configure a setpoint condition to trigger waveform recording, you must program one of the setpoint's two ACTION parameters to WFR.

The programmable TIME DELAY TO OPERATE delay can be used to delay a setpoint from becoming active, thus delaying the triggering of the waveform recorder. This is described in detail in Chapter 7. The TIME DELAY TO RELEASE parameter can be used to delay when the setpoint becomes inactive, but this has no effect on waveform recorder triggering.

##### Manual Trigger Override

A waveform recorder trigger command received via communications overrides any setpoint controlled waveform recorder action. Once the recorded data is uploaded via communications, the recorder automatically re-arms and returns to setpoint control.

#### 6.4.5 SNAPSHOT LOG TRIGGERING

Triggering of Snapshot Logs using setpoints allows you to define groups of important measured parameters or status information whose values or conditions are logged when a setpoint becomes active. The Snapshot Log records all user-defined parameters with a time-stamp. This can provide detailed operations information to aid in isolating problem sources.

Any of the eleven standard setpoints can be programmed to trigger any of the eight standard Snapshot Logs. Only high-speed setpoints can be programmed to trigger a high-speed Snapshot Log, if one has been configured.

Snapshot Logs can be triggered by setpoints in one of two ways:

##### ONE SHOT

If the Snapshot Log's programmable INTERVAL parameter is set to 0 seconds, the log records *once* when the setpoint condition initially occurs.

##### GATED

If the programmable INTERVAL parameter is set to a non-zero time interval, the Snapshot Log records once when the setpoint condition initially occurs, and continues to record at the specified intervals the entire time the setpoint remains in an active condition.

Note that a high-speed Snapshot Log operates differently than a standard log, using an additional user-defined *stop condition*. This is described in more detail in Chapter 8.

##### Programming

Setpoint parameters related to snapshot logging are not accessible via the front panel of the 3720 ACM. To configure a setpoint condition to trigger a Snapshot Log, you must program the setpoint via communications. One of the setpoint's two ACTION parameters must be set to SLX, where x represents the standard Snapshot Log number (1 to 8), or to HSS for the high-speed Snapshot Log, if configured.

The programmable TIME DELAY TO OPERATE delay can be used to delay a setpoint from becoming active, thus delaying the triggering of the Snapshot Log. The TIME DELAY TO RELEASE parameter can be used to delay when the setpoint becomes inactive, but this has no effect on Snapshot Log triggering.

##### Application Example

Setpoint triggered snapshot logging is ideal for saving critical information prior to the clearing of registers or logs. For example, suppose a standard setpoint is configured to trigger on NEW HOUR, DAY, MONTH OR YEAR. To save the current values of the TOU registers or min/max parameters, assign those parameters of interest to a standard Snapshot Log, then configure the log to be *one-shot* triggered by the setpoint. The first action of the setpoint would be to trigger the log. The second action would be to clear the TOU registers, or Min/Max Log. Each time a new month occurs, for example, the current data is saved, and the parameters are reset. See Section 6.4.6 for information on clearing registers and logs.

##### NOTE

As mentioned in Section 5.4.1, the ACTION1 of any setpoint is always performed before ACTION2. Therefore it is very important that ACTION1 performs the Snapshot Log trigger, while ACTION2 performs the subsequent clearing function. Otherwise the current data will always be lost.

#### 6.4.6 CLEARING FUNCTIONS

Preset and programmable Min/Max Logs, TOU registers and counters can be cleared automatically using setpoints. Refer to Figure 3.4.6f for a detailed list of the clearing functions you can assign to a setpoint-triggered action.

## 6.5 PROGRAMMING SETPOINTS

### Setpoint Parameter Form

It is recommended that setpoint utilization be planned using a *Setpoint Parameter Form*. Appendix B provides a blank Setpoint Parameter Form for this purpose. This form contains the setpoint information that the user programs into the 3720 ACM. A copy of this information should be kept with the meter.

### Programming Example

Figure 6.6.1 provides an example of a Setpoint Parameter Form used to plan setpoint usage. The form contains all the parameter values required to program the 3720 ACM to perform the operations described in the following example.

#### EXAMPLES

1. Setpoints S01 to S02 are used to sense loads which are over 70% of the breaker rating. This includes over current and over voltage conditions. Setpoints S03 to S04 are used to sense excessive power factor lead or lag. Setpoint S05 is used to sense a voltage unbalance condition. For all these conditions, Relay 2 is triggered to operate as an alarm relay, with its output connected to a buzzer.

Setpoint S01 is also used to trigger Snapshot Log #1 to record the real-time readings of measured parameters associated with the over current condition.

2. Relay 3 is used by setpoint S06 as a KW Demand control relay, and is connected to a sheddable load or backup generator.
3. Setpoints H01 to H02 are used to sense over and under voltage conditions. Both setpoints are triggering Relay 1 to operate as a trip relay, which is connected to a breaker shunt trip input. Setpoint H01 is also used to trigger the waveform recorder if an over voltage condition occurs.

### Disabled Relay Control in Programming Mode

During the programming of a setpoint via communications, any relay currently assigned to that setpoint is temporarily forced into its released state (normally-open contacts forced open). The 3720 ACM then re-evaluates setpoint conditions based on the new parameter settings and performs any required relay operation.

Figure 6.6.1 Setpoint Parameter Form Example

SETPOINT PARAMETER FORM							
SETPOINT	TRIGGER	HI LIM	TD OP	LO LIM	TD REL	ACTION1	ACTION2
S01	Over Current	2100	10	2000	1	Relay2, Alarm	Snapshot1
S02	Over Voltage	300	10	290	1	Relay2, Alarm	
S03	Under PF Lag	90	10	85	10	Relay2, Alarm	
S04	Under PF Lead	90	10	85	10	Relay2, Alarm	
S05	Volts Unbalance	30%	5	10%	1	Relay2, Trip	
S06	Over KWD	1200	10	900	10	Relay3, DmdCntl	
S07	Not Used						
S08	Not Used						
S09	Not Used						
S10	Not Used						
S11	Not Used						
H01	Over Voltage	332	5	290	1	Relay1, Trip	WaveRecord
H02	Under Voltage	270	5	220	1	Relay1, Trip	
H03	Not Used						
H04	Not Used						
H05	Not Used						
H06	Not Used						

## 6.6 POWER OUTAGES

When the power feed to the 3720 ACM is interrupted, even momentarily, the output relays release. When power is restored, the 3720 ACM allows a 3 second settling time. After this interval the setpoint conditions are re-evaluated and, if appropriate, the relays operate after the programmed time delays.

If any relay has been forced operated or forced released using commands issued via the communications port prior to the power outage, it is released when the outage occurs. When power is restored, the 3720 ACM resumes normal setpoint operation as described above. Relays will *not* automatically return to a forced operated or forced released condition following a power outage.

## 7 WAVEFORM CAPTURE & RECORDING

### 7.1 INTRODUCTION

The 3720 ACM is equipped with digital waveform sampling capabilities. The 3720 ACM provides two powerful methods for acquiring waveform data: *waveform capture* and *waveform recording*. Waveform capture can be used for detailed power quality analysis beyond that offered by the on-board harmonics measurements. Waveform recording can assist in analyzing short duration events such as faults, surges, etc.

Waveform capture and recording are independent functions and can be used concurrently. Each function can be independently triggered by a user-defined setpoint condition or by a command issued via communications.

### 7.2 WAVEFORM CAPTURE

#### 7.2.1 THE IMPORTANCE OF POWER QUALITY MONITORING

Power quality has become a foremost concern for power utilities and their customers due to an increasing presence of induced harmonic voltages and currents in industrial, commercial and residential electrical supplies. Harmonics are typically generated within a facility's power distribution system by non-linear loads (variable frequency drives, UPS systems, HVAC and lighting systems, computers, etc.)

Poor power quality can have serious and potentially damaging consequences, including equipment malfunctions or failures, reduced efficiency and mechanical vibration in motors, or incorrect tripping and/or failure of circuit breakers. Harmonic currents from individual phases can also add in the neutral line, sometimes producing dangerously high neutral currents.

As harmonic sources become more prevalent, it is important to have the analytical tools necessary to identify potential problem sources and help in determining the preventative or corrective measures necessary to improve power quality in electrical distribution systems.

#### 7.2.2 USING CAPTURED DATA

Waveform capture allows you to perform high-speed sampling of the V1, V2, V3, VAUX, I1, I2, I3, or I4 (neutral current) inputs. One full cycle of the signal at a *single* selected input is sampled at a rate of 128 samples per cycle. All samples are taken synchronous to the line frequency and within one input cycle.

Sampled waveform data is stored in on-board memory and can be read via the communications port. The high sampling rate used by the 3720 ACM produces high-resolution data which allows analysis of frequency components to the 63rd harmonic.

POWER MEASUREMENT's SCADA software can be used to upload captured waveform data from the 3720 ACM to a master computer station and display the waveforms on the computer screen (see Figure 7.2.2a). The SCADA software automatically performs a Fast Fourier Transformation on each waveform, and provides an indication of total harmonic distortion and a breakdown of individual frequency components both in graphical (Figure 7.2.2b) and tabular form (Figure 7.2.2c) to the 63rd harmonic. This wide variety of data formats can help you quickly pinpoint the source and severity of harmonics, evaluate which sources must be minimized, and develop corrective strategies.

#### 7.2.3 TRIGGERING FROM A SETPOINT

Triggering waveform capture from a setpoint allows you to analyze the harmonic character of any single selected voltage or current input which existed coincidental with the user-defined setpoint condition. An example might be a power line fault condition which is being produced by high harmonic content.

Triggering can be performed by either a high-speed or standard type setpoint. The user must set the programmable ACTION1 or ACTION2 parameter for the selected setpoint to WAVE CAPTURE. This parameter option must be programmed via communications. You must also select the input that is to be captured (V1, V2, V3, VAUX, I1, I2, I3, I4).

The TIME DELAY TO OPERATE parameter can be used to provide an additional delay before the setpoint becomes active, thus delaying when waveform capture is triggered. The TIME DELAY TO RELEASE parameter has no effect.

When the setpoint becomes active (following any programmed time delay), waveform capture is automatically initiated on the selected input and the data is held in memory. No subsequent capture actions are allowed until the currently stored data is read via communications, and waveform capture has been rearmed.

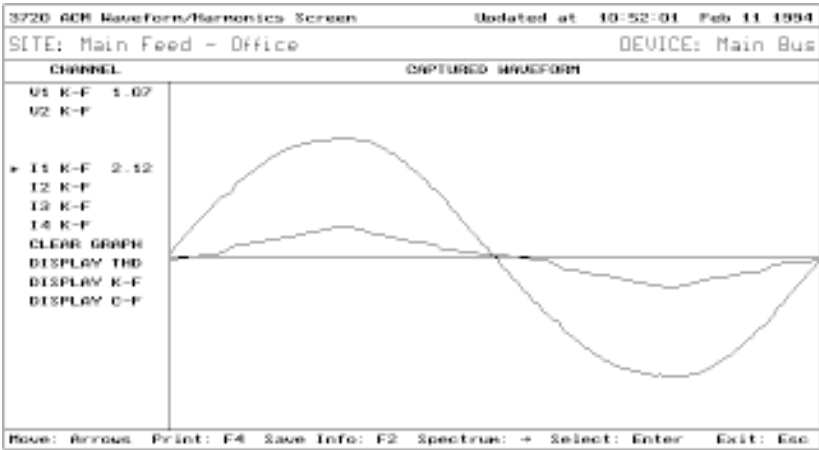
If the 3720 ACM is being used with the SCADA software, the computer station senses when the setpoint condition and subsequent waveform capture triggering occurs. The captured data is then automatically uploaded to the computer along with its time stamp. The SCADA software automatically rearms the waveform capture feature after the data has been uploaded. The SCADA software's waveform capture screen can be used to retrieve one or more captured waveforms from the hard disk and display them graphically with the time stamp and an indication of the trigger source.

7.2.4 TRIGGERING MANUALLY VIA COMMUNICATIONS

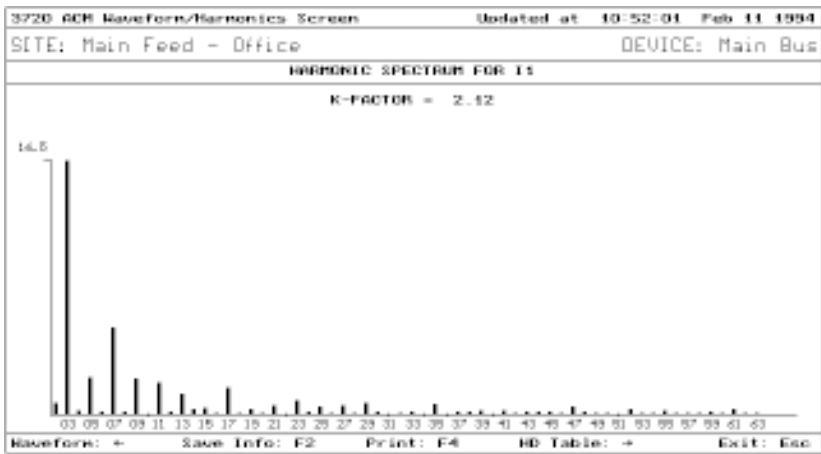
You can manually initiate waveform capture from the master station. Manual trigger commands override any currently active setpoint-triggered waveform capture.

With the SCADA software, you can perform waveform capture for each of the eight possible inputs individually. A command from the computer immediately initiates capture at the 3720 ACM. The computer automatically uploads and displays the waveform on the screen. The waveforms captured in turn for each of the eight inputs can be displayed together on the screen, presented with correct phase relationships.

Figure 7.2.2 M-SCADA / L-SCADA Harmonics Analysis Screens



a) Captured Waveform Screen



b) Harmonic Spectrum Screen

3720 ACM Waveform/Harmonics Screen				Updated at 10:52:01 Feb 11 1994			
SITE: Main Feed - Office				DEVICE: Main Bus			
HARMONIC DISTORTION TABLE FOR I1							
Hz	THD	Hz	THD	Hz	THD	Hz	THD
01	100.0	33	0.2	02	0.0	34	0.1
03	16.5	35	0.7	04	0.3	36	0.1
05	2.4	37	0.2	06	0.2	38	0.2
07	5.6	39	0.3	08	0.2	40	0.0
09	2.3	41	0.3	10	0.1	42	0.1
11	2.1	43	0.2	12	0.2	44	0.2
13	1.4	45	0.2	14	0.4	46	0.1
15	0.5	47	0.5	16	0.1	48	0.2
17	1.0	49	0.1	18	0.1	50	0.1
19	0.3	51	0.0	20	0.1	52	0.3
21	0.6	53	0.2	22	0.0	54	0.1
23	1.0	55	0.3	24	0.2	56	0.1
25	0.5	57	0.1	26	0.1	58	0.1
27	0.7	59	0.2	28	0.1	60	0.1
29	0.0	61	0.3	30	0.2	62	0.1
31	0.0	63	0.1	32	0.2		
K-FACTOR = 2.12							
Spectrum: +				Print: F4		Export Info: F2	
						Exit: Esc	

c) Harmonics Table Screen



7.3 WAVEFORM RECORDING

7.3.1 USING RECORDED DATA

Power line faults, surges, sags, or other disturbances can cause expensive service interruptions. The 3720 ACM waveform recording feature is ideal for fault and surge analysis, and to aid in fault location. It provides a powerful method for analyzing the conditions occurring before, during, and after a power fluctuation or failure. For example, fault recording can be performed by triggering on a status input setpoint which is monitoring a breaker trip. Other applications include the recording of voltage or current transients, transformer inrush currents, or motor start-up currents.

Waveform recording allows for simultaneous 12, 18, or 36-cycle sampling of *all eight* voltage and current inputs at a rate of 16 samples per cycle. The recorder runs continuously until triggered by a user-specified setpoint condition or by a manual command made via communications. You can also set a programmable trigger delay, which allows you to define the amount of pre-event and post-event waveform data to be captured.

POWER MEASUREMENT’s SCADA software can be used to display one or more of the eight recorded waveforms on the computer screen. The waveforms for single inputs or groups of inputs can be displayed together, presenting a comprehensive picture of the power line conditions surrounding the disturbance (see Figure 7.3.1). The screen provides zoom and pan capabilities, as well as a set of movable cursors that can help quickly pinpoint the absolute and relative times of waveform characteristics.

7.3.2 CONFIGURING THE RECORDER

The on-board memory of the 3720 ACM can store a total of 36 cycles of waveform data for each input. This memory space can be configured to store single or multiple events. Choices are:

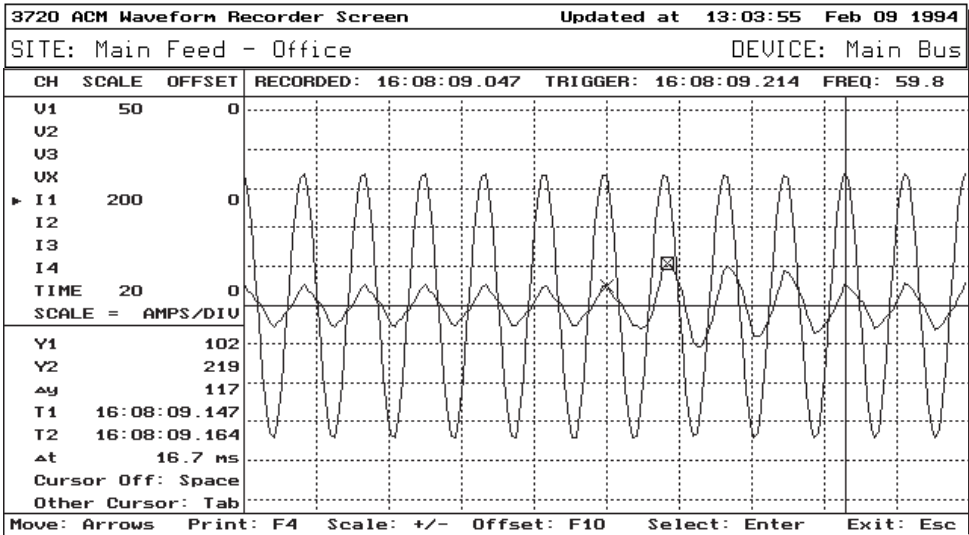
- 3x12. Three 12-cycle events.
- 2x18. Two 18-cycle events.
- 1x36. One 36-cycle event.

You must program the WFR CONFIGURATION parameter via communications to select one of the options above.

Choosing either the 3x12 or 2x18 multiple waveform configuration allows the 3720 ACM to record many events that may be close together in time. In the case of the 3x12 option, up to 3 events could be stored on-board until uploaded to the computer.

The 1x36 configuration is ideal for recording events of longer duration; however, it is recommended this option not be used if events are expected to be close together. For example, a recloser activation may generate multiple, closely spaced contact closures.

Figure 7.3.1 M-SCADA / L-SCADA Waveform Recorder Screen





### 7.3.3 TRIGGERING FROM A SETPOINT

#### Programming

Triggering can be performed by either a high-speed or standard type setpoint. You must set the programmable ACTION1 or ACTION2 parameter for the selected setpoint to WFR. This parameter option must be programmed via communications.

As described in Section 6.4.4, the programmable TIME DELAY TO OPERATE delay can be used to delay a setpoint from becoming active, thus delaying the triggering of the waveform recorder (see Section 7.3.4). The TIME DELAY TO RELEASE parameter can be used to delay when the setpoint becomes inactive, but this has no effect on waveform recorder triggering.

#### Operation

The waveform recorder runs continuously until it is triggered by the setpoint event. When the setpoint becomes active, the waveform recorder is triggered (following any programmed time delay) and the window of cycles (i.e. 12, 18, or 36) of each input are frozen in memory along with a time stamp.

The waveform recorder is automatically rearmed so that successive recordings can occur until all of the recorder memory has been filled. This would occur after the third recording of 12 cycles for the 3x12 configuration, or after the second recording for the 2x18 configuration. The memory is always filled after the single recording for the 1x36 cycle configuration.

#### NOTE

To avoid duplication of waveform data, recorder triggers must be at least 2 cycles apart. Following the initial trigger, all subsequent triggers within a 2-cycle period will be ignored.

Once the recorder memory is filled, the recorder is disarmed. All subsequent setpoint triggers are ignored until the currently stored data is read via communications. Manual trigger commands can override this (see Section 7.3.4). The recorder is rearmed automatically following transfer of the waveform recorder data.

Using the SCADA software, the master station automatically identifies if the waveform recorder is currently storing one or more recorded events. If so, all recorded events for all inputs are uploaded to the computer along with their time stamp and archived to the hard disk.

The SCADA software's waveform recorder screen can be used to retrieve one or more channels of each recorder event from the hard disk and graphically display them with the time stamp, an indication of the trigger source, and the location of the trigger point on the waveform(s).

### 7.3.4 ADJUSTING THE TRIGGER POINT PRE-EVENT & POST-EVENT DATA

Using high-speed setpoints to trigger the waveform recorder, you are able to acquire both pre-event data and post-event data. If the programmable TIME DELAY TO OPERATE parameter is set at zero (the default), the time that the setpoint event occurred will exist within the window of cycles recorded by the waveform recorder (see Figure 7.3.4, Example 1).

The recorder exhibits an inherent *trigger delay* of up to 2 cycles between when the external or internal setpoint event occurs and the setpoint has been fully evaluated. The best case is for this delay 1 cycle. At this point the setpoint performs the action of freezing the waveform recorder. This process exhibits an additional *stop delay* of up to 2 cycles. In total, this can provide up to 4 cycles of post-event data, without the addition of a user-programmable delay (as described below).

Using standard setpoints to trigger the waveform recorder provides a much slower response. This slower response allows the waveform recorder to provide only post-event data. The time that the event occurred could exist 1 to 2 seconds prior to the start of the window of cycles recorded by the waveform recorder.

#### NOTE

When using high-speed or standard setpoints to trigger the waveform recorder, the actual trigger point depends on the type of setpoint parameter being monitored (i.e. under voltage, status input change, etc.) and the additional programmable delay that you define.

#### Using Programmable Delays

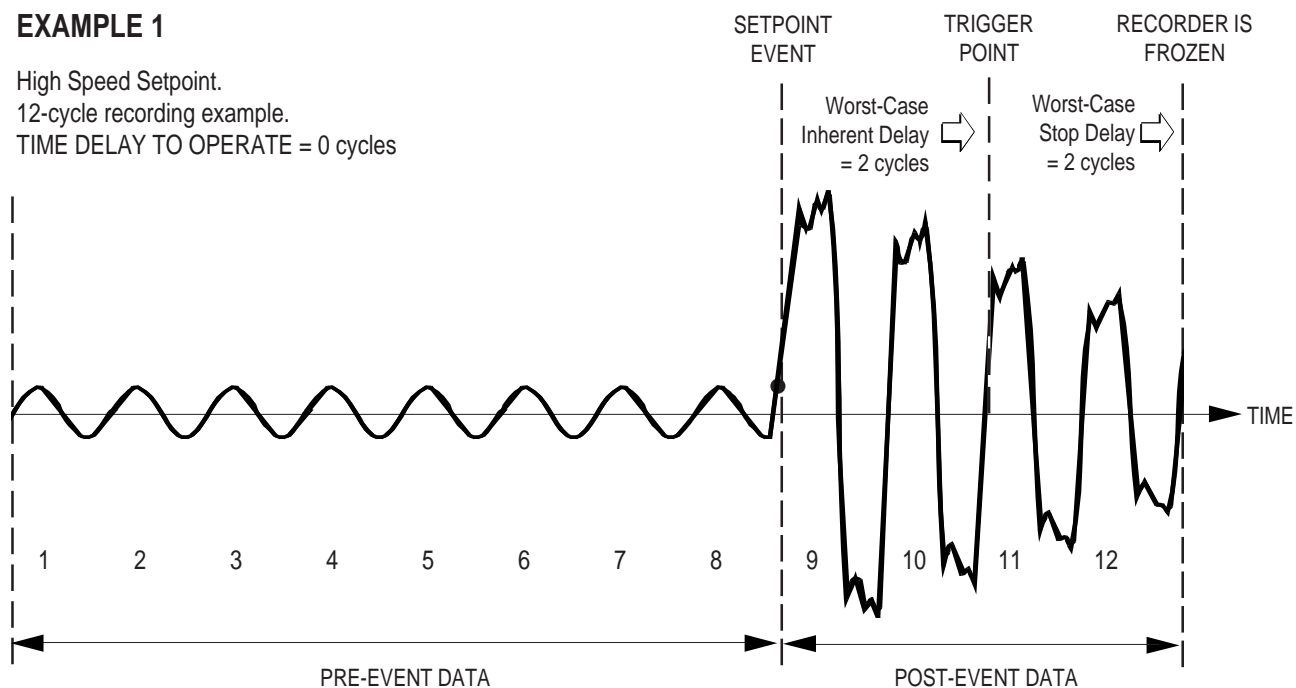
The TIME DELAY TO OPERATE parameter can be used to vary the amount of pre-event and post-event data recorded by the waveform recorder.

If a high-speed setpoint is being used to trigger the waveform recorder, the TIME DELAY TO OPERATE parameter can be used to provide additional cycles of post-event data. The setpoint event time will effectively be moved earlier within the window of recorded cycles, reducing the amount of pre-event data and increasing the amount of post-event data.

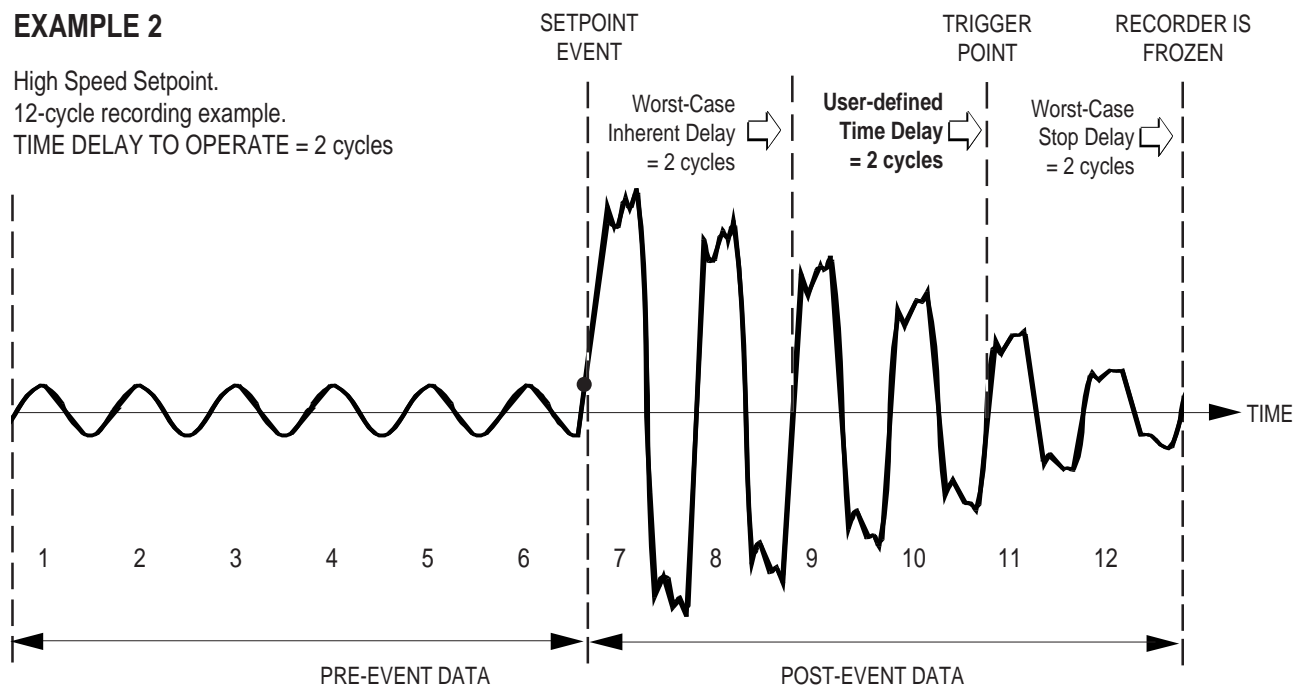
Figure 7.3.4, Example 2 shows how setting TIME DELAY TO OPERATE = 2 (cycles) can cause the trigger point to be displaced by 2 cycles later in time, making the location of the setpoint event 2 cycles earlier in the window of recorded cycles. Note that the TIME DELAY TO OPERATE is added to the 4 cycle (worst case) total inherent trigger and stop delay of the recorder.

**Figure 7.3.4** Waveform Recorder High-Speed Trigger Point Adjustment**EXAMPLE 1**

High Speed Setpoint.  
 12-cycle recording example.  
 TIME DELAY TO OPERATE = 0 cycles

**EXAMPLE 2**

High Speed Setpoint.  
 12-cycle recording example.  
 TIME DELAY TO OPERATE = 2 cycles



**NOTE**

As mentioned in Section 6.3.2, for a setpoint to become active, the active condition must exist for a period greater than the value of the `TIME DELAY TO OPERATE` parameter. Therefore, no additional programmable delays should be applied when using the waveform recorder to capture events of short duration (2 to 6 cycles). Otherwise, the recorder may fail to trigger.

Adding a large delay causes the setpoint event time to exist outside of the window of recorded cycles, causing the recorder to provide only post-event data.

As mentioned previously, if a standard setpoint is being used to trigger the waveform recorder, the cycles recorded will always be post-event data. The `TIME DELAY TO OPERATE` parameter can be used to shift this window later in time, in increments of *seconds*.

### 7.3.5 TRIGGERING MANUALLY VIA COMMUNICATIONS

You can manually trigger waveform recording via the communications port. Using the SCADA software, you can manually initiate waveform recording from the master station. A command from the computer immediately initiates capture at the 3720 ACM, and the data is subsequently uploaded. The `TIME DELAY TO OPERATE` parameter has no effect on manual triggering.

Manual trigger commands override any currently active setpoint triggered waveform recording.

## 8 ON-BOARD DATA LOGGING

### 8.1 INTRODUCTION

Data logging can be extremely useful in the study of growth patterns, for scheduling loads and for cost allocation, for isolating problem sources, or for analyzing a variety of power system operating conditions.

The 3720 ACM supports three types of on-board data logging:

- Event Log
- Minimum / Maximum Logs
  - 1 Preset (Master)
  - 16 Programmable
- Programmable Snapshot Logs
  - 8 Standard, one of which can be assigned as High-Speed

All logged data is stored in internal non-volatile memory and is accessible via the communications port. Measured values from the Preset Min/Max Log are also accessible from the front panel of the 3720 ACM. These parameters must be assigned to the GROUP buttons (see Chapter 3).

### 8.2 EVENT LOG

The Event Log records automatically the 100 most recent events. A wide variety of event types are recorded by this log:

- Power-up and power-down activity.
- Setpoint (alarm) conditions.
- Relay activity. This includes operate/release actions triggered by setpoints or manually via communications.
- Status input activity. If desired, the logging of status input activity can be enabled via communications.
- Triggering of the waveform capture, waveform recorder, and snapshot logging features. This includes waveform functions triggered by setpoints and snapshot logging functions triggered by setpoints.
- Changes made to the user-programmable parameters from the front panel or via communications.
- Self-diagnostic events.

The Event Log can be used to record a complete sequence-of-events record for breaker and transfer switch operations, alarm conditions, and equipment starts and stops.

Figure 8.2.1 illustrates a typical 3720 ACM Event Log displayed by POWER MEASUREMENT's SCADA software. The most recent events are found at the top of the log screen.

Note that when a setpoint is programmed to trigger an action (relay control, waveform recording, etc.), the setpoint activation and the subsequent setpoint action are logged separately.

For example, the highlight bar in Figure 8.2.1 is located on an event that describes the standard setpoint S03 going into an active state and triggering a reset of all TOU demand registers (RESET TOU DMD ALL). This is one of two setpoint actions that occurred. The first action can be seen directly below, where Snapshot Log 2 was triggered (SL2 TRIGGERED). The actual setpoint condition that caused the setpoint to go into an active state can be found directly below that record. It shows that new day setpoint event (NEW DAY) occurred and triggered, which in turn activated Standard Setpoint 3 (SETPOINT S03 ACTIVE). Each subsequent action performed due to a single setpoint activation is recorded separately in the Event Log.

Each event record stored in the Event Log includes:

#### Cause

This identifies the setpoint condition that activated or deactivated a setpoint, a user action (such as device programming), or any other event type that occurred.

#### (Cause) Value

If the event was a setpoint being activated or deactivated, the value of the measured parameter that triggered the setpoint is recorded. If a setpoint action is being logged, the new state of the setpoint is recorded.

#### Effect

If the event was a setpoint being activated or deactivated, the setpoint is identified. If a setpoint action is being logged, the action taken is identified. If any other type of event occurred, it is described.

#### (Effect) Value

If the event was a setpoint being activated or deactivated, the new state of the setpoint is recorded.

#### Date & Time

The event is date and time-stamped. The date provides the year, month, and day. Event times are recorded in hours, minutes, seconds and milliseconds. Logged time-stamps are provided with millisecond resolution; however, time accuracies vary depending on the type of parameter being logged and other factors. Refer to Section 8.6 for more information.

Figure 8.2.1 M-SCADA Event Log Screen

3720 ACM Event Log Screen			Updated at 15:56:14 Feb 08 1994		
SITE: Main Feed - Office			DEVICE: Office3720		
CAUSE	VALUE	EFFECT	VALUE	DATE	TIME
SETPOINT S03	ACTIVE	RESET TOU DMD ALL	0	94/02/08	00:00:01.163
SETPOINT S03	ACTIVE	SL2 TRIGGERED	1	94/02/08	00:00:01.143
NEW DAY	1	SETPOINT S03	ACTIVE	94/02/08	00:00:01.131
COMMUNICATIONS		LOG CHANGE		94/02/07	13:18:51.768
EXTERNAL		USER TASK CHANGE	130	94/02/07	13:15:03.821
COMMUNICATIONS		CONTROL CHANGE		94/02/07	13:15:03.518
COMMUNICATIONS		SETUP CHANGE		94/02/07	13:15:03.518
COMMUNICATIONS		USER FEATURE SET	23	94/02/07	13:15:03.486
NEW DAY	0	SETPOINT S03	INACTIVE	94/02/07	00:00:02.120
SETPOINT S03	ACTIVE	RESET TOU DMD ALL	0	94/02/07	00:00:01.148
SETPOINT S03	ACTIVE	SL2 TRIGGERED	1	94/02/07	00:00:01.145
NEW DAY	1	SETPOINT S03	ACTIVE	94/02/07	00:00:01.116
SETPOINT S01	ACTIVE	RELAY #1	ON	94/02/06	13:25:46.125
U LN RT	1832	SETPOINT S01	ACTIVE	94/02/06	13:25:46.123
EXTERNAL		METER POWER UP		94/02/06	13:25:11.924
EXTERNAL		METER POWER DN		94/02/06	13:24:38.892
NEW DAY	0	SETPOINT S03	INACTIVE	94/02/06	00:00:02.015
SETPOINT S03	ACTIVE	RESET TOU DMD ALL	0	94/02/06	00:00:01.056
Move: Arrows Home End PgUp PgDn Alt-S			Print: F4		
			Exit: Esc		

## 8.3 MINIMUM / MAXIMUM LOGS

### 8.3.1 PRESET MIN/MAX LOG

The Preset Min/Max Log is a non-programmable log that automatically records the extreme values for all parameters measured by the 3720 ACM. This includes all voltage, current, power, frequency, power factor, harmonic distortion, and auxiliary input parameters. Minima and maxima are also provided for all demand measurement modes, including both thermal and user-defined sliding window parameters.

The 3720 ACM Preset Min/Max Log can be used to determine such values as the highest loading on a plant or feeder, peak demand, voltage operating ranges, worst case power factor, highest VAR loading for capacitor sizing, etc.

Minima and maxima for each parameter are logged independently with date and time stamp (see Figure 8.3.1). Each value in the Preset Min/Max Log can be accessed from the front panel of the 3720 ACM by assigning the min or max measurement mode for the desired parameter to one of the GROUP buttons (see Chapter 3).

Figure 8.3.1 M-SCADA Preset Min/Max Log Screen

3720 ACM RT Min/Max Screen				Updated at 16:03:42 Feb 08 1994	
SITE: Main Feed - Office				DEVICE: Main Bus	
PARAMETER	MIN VALUE	MIN DATE/TIME	MAX VALUE	MAX DATE/TIME	
U LN RT	104	94/02/07 08:37:32	1105	93/01/01 00:01:11	
U A RT	107	94/02/07 09:39:54	1101	93/01/01 00:01:11	
U B RT	102	94/02/07 08:37:32	1113	93/01/01 00:00:59	
U C RT	101	94/02/07 08:37:32	1101	93/01/01 00:00:15	
U LL RT	181	94/02/07 08:37:32	1913	93/01/01 00:01:11	
U AB RT	184	94/02/07 08:37:32	1917	93/01/01 00:01:34	
U BC RT	176	94/02/07 08:37:32	1917	93/01/01 00:01:14	
U CA RT	183	94/02/07 08:37:32	1907	93/01/01 00:01:11	
AMP RT	19	94/02/04 23:27:12	869	93/01/01 00:01:22	
AMP A RT	16	94/02/04 23:13:26	1019	93/01/01 00:00:36	
AMP B RT	19	94/02/05 06:48:08	885	93/01/01 00:02:50	
AMP C RT	21	94/02/04 23:27:12	854	93/01/01 00:01:43	
I 4 RT	0	93/01/01 00:00:10	0	93/01/01 00:00:10	
VAUX RT	1138	94/02/04 10:59:55	1142	94/02/08 12:20:10	
KW RT	5	94/02/04 23:27:12	2708	93/01/01 00:01:22	
KW A RT	1	94/02/05 07:20:46	1084	93/01/01 00:00:36	
KW B RT	2	94/02/04 19:06:07	906	93/01/01 00:02:50	
KW C RT	2	94/02/04 23:27:12	876	93/01/01 00:01:43	
Move: PgUp PgDn		Print: F4		Clear Min/Max: F3	
				Exit: Esc	

### 8.3.2 PROGRAMMABLE MIN/MAX LOGS

The 3720 ACM also provides 16 Programmable Min/Max Logs. For each log, you can define up to 16 time-stamped parameters.

Each log is triggered by the first parameter in its list, which is named the *trigger parameter*. When a new minimum for the trigger parameter is reached, the log simultaneously records:

- the trigger parameter's minimum value
- the date and time the minimum occurred
- all coincident real-time values for all other parameters in the list.

Similarly, when a new maximum for the trigger parameter is recorded, the values for all other parameters are stored. This provides two lists of coincident values, one for the trigger parameter's minimum and one for its maximum (see Figure 8.3.2).

The Programmable Min/Max Logs are ideal for analyzing overall power system characteristics on the occurrence of a specific load limit or fault condition. For example, you could program a log to record all per-phase kW, kVAR, and PF demand values when total kW demand peaks.

## Programming

The Programmable Min/Max Logs may only be programmed via communications. POWER MEASUREMENT's SCADA software provides setup screens for programming all logs.

### 8.3.3 RESETTING THE MIN/MAX LOGS

The minima and maxima values in both the Preset and Programmable Min/Max Logs can be reset together from either the front panel of the 3720 ACM, or individually via communications. The logs can also be cleared automatically using setpoints (see Section 6.4.6).

From the front panel, set the CLEAR MIN/MAX? parameter to YES in programming mode. All values are reset when you advance to the next parameter, or return to display mode.

**Figure 8.3.2** M-SCADA Programmable Min/Max Log Screen

3720 ACM MIN/MAX LOG 02 Screen				Updated at 12:37:26 Feb 08 1994		
SITE: Main Feed - Office				DEVICE: Main Bus		
PARAMETER	MIN VALUE	DATE	TIME	MAX VALUE	DATE	TIME
AMP RT	19	94/02/04	23:27:12	182	94/02/07	12:23:51
AMP A RT	16			181		
AMP B RT	20			201		
AMP C RT	21			165		
A UNBAL RT	16			10		
KW RT	5			56		
KVAR RT	4			23		
KVA RT	6			60		
PF RT	LAG	78		LAG	93	

Move: Alt-S
Print: F4
Clear Min/Max: F3
Exit: Esc



## 8.4 PROGRAMMABLE SNAPSHOT LOGS

### 8.4.1 INTRODUCTION

3720 ACM Snapshot Logs are *historical* or *trend* logs. Up to 8 *standard* logs may be defined. Snapshot Log 8 can be alternatively configured as a *high-speed* log. Each standard or high-speed log can record up to 12 channels of data (see Figure 8.4.1). Each snapshot record is stored with a date and time-stamp. This can provide you with detailed operations information to aid in isolating problem sources.

Each Snapshot Log can be independently triggered either on a user-defined time interval basis, or from a setpoint.

Snapshot Logs can be used to replace traditional strip chart recorders. Data collected by the logs can be used to produce daily/weekly/monthly load profile graphs for power, demand, power factor, etc. Data can also be used for time-of-use or billing calculations.

The following section describes the configuration and operation of standard and high-speed Snapshot Logs. All configuration must be performed via communications.

### 8.4.2 MEMORY ALLOCATION

The large capacity of the 3720 ACM on-board memory allocated to snapshot logging is partitioned between the individual Snapshot Logs you programmed.

The amount of memory space each Snapshot Log requires depends on the number of parameters (channels) being logged, the type of parameters being logged (some parameters are not compressible), the maximum number of snapshot records stored, and whether the log is triggered by time interval or setpoint. Triggering is described in the following sections. Setpoint-triggered snapshots require somewhat more memory than interval-triggered snapshots.

The number of Snapshot Logs, number of parameters per log, triggering method, time intervals (if interval triggered) and total number of records per log can be set to make best use of the available memory for the specific application(s).

The parameters that cannot be compressed include KWh, KVAh, KVARh, time values, various status registers and scalable status input counters. All other parameters can be compressed. If the parameters you wish to log are compressible, you will be able to store more records. Note that compression is not used for the high-speed log.

Figure 8.4.2 illustrates how various log assignments have different memory requirements. All logs in the example are interval-triggered.

POWER MEASUREMENT's SCADA software allows you to define the maximum 3720 ACM memory space used by each log as a percentage of the total available space. To help you decide on the amount of memory to allocate to each log, the SCADA software provides a Maximum Remaining Memory indicator in percent. The screen also provides a value indicating the maximum number of records that can be stored by the log using the present settings. Increasing the memory allocation increases the number of records possible. Conversely, increasing the number of parameters logged decreases the number of records possible.

Figure 8.4.1 M-SCADA Standard Snapshot Log Screen

3720 ACM SNAPSHOT LOG 2 Screen				Updated at 16:00:04 Feb 08 1994	
SITE: Main Feed - Office				DEVICE: Main Bus	
DATE	TIME	KW RT	KW A RT	KW B RT	KW C RT
94/02/08	16:15:00.000	36	12	14	10
94/02/08	16:00:00.000	24	8	7	8
94/02/08	15:45:00.000	20	7	7	6
94/02/08	15:30:00.000	20	7	7	6
94/02/08	15:15:00.000	37	14	15	8
94/02/08	15:00:00.000	19	6	6	6
94/02/08	14:45:00.000	25	8	9	8
94/02/08	14:30:00.000	26	11	8	7
94/02/08	14:15:00.000	43	13	18	12
94/02/08	14:00:00.000	20	7	6	7
94/02/08	13:45:00.000	18	7	6	6
94/02/08	13:30:00.000	44	14	18	12
94/02/08	13:15:00.000	39	13	16	10
94/02/08	13:00:00.000	21	8	6	6
94/02/08	12:45:00.000	23	7	8	7
94/02/08	12:30:00.000	43	15	15	12
94/02/08	12:15:00.000	45	14	17	14
94/02/08	12:00:00.000	22	7	7	8
Move: Keypad Alt-S Print: F4				Trending: F10 Exit: Esc	

**Figure 8.4.2** Snapshot Log Capacity Examples - Interval Triggered

	NUMBER OF LOGS	PARAMETERS/LOG	PARAMETER TYPE	INTERVAL	CAPACITY
<b>Single Log Example #1</b>	1 Log	3	Non-compressible	15 min.	30 days
<b>Single Log Example #2</b>	1 Log	3	Compressible	15 min.	48 days
<b>Single Log Example #3</b>	1 Log	12	Compressible	15 min.	17 days
<b>Single Log Example #4</b>	1 Log	3	1 Non-compressible 2 Compressible	15 min.	40 days

*Note: All examples are for standard Snapshot Logs.*

### 8.4.3 STANDARD SNAPSHOT LOGS

Up to 8 standard Snapshot Logs can be defined. Note that the HIGH SPEED FEATURE parameter must be set to TOC for Snapshot Log 8 to be configured as a standard log. See Section 8.4.4 below for more information.

#### Logged Parameters

The parameter recorded by each channel of a log is user-programmable. The values of any real-time parameter, energy parameter, status parameter, or TOU register can be logged. Chapters 4 and 5 list these parameters. High-speed parameters can only be logged by a high-speed log (see Section 8.4.4).

#### Triggering

##### TIME INTERVAL

Time interval triggering allows a Snapshot Log to run continuously, automatically recording all channels of data at user-defined time intervals. To set a log for interval triggering, the programmable TRIGGER TYPE parameter must be set to INTERVAL. The user-defined time interval is set using the INTERVAL parameter. For a standard Snapshot Log, this can be set to a range between 1 second and 400 days.

This method of triggering a log is ideal for analyzing power usage trends for the study of growth patterns, or for scheduling loads. Historical data recorded using a time interval triggered snapshot log can be graphically viewed in the SCADA software using the *Historical Trending* feature (see Figure 8.4.3a).

#### SETPOINT

Standard Snapshot Logs may also be triggered by any of the eleven standard setpoints. This method of triggering a log is ideal for analyzing system conditions which occur periodically due to faults, power fluctuations, or other events (breaker trip, etc.) Setpoint conditions can include harmonic distortion levels, status input changes, and more (see Chapter 6). High-speed setpoints cannot be used for this purpose.

To set a log for setpoint triggering, the programmable TRIGGER TYPE parameter must be set to SETPOINT. The ACTION1 or ACTION2 for the standard setpoint used must be configured as SNAPSHOT X (where X = 1 to 8).

Logs can be triggered by setpoints in one of two ways:

- *One Shot.* If the programmable INTERVAL parameter is set to 0 seconds, the Snapshot Log records once when the setpoint condition initially occurs (see Figure 8.4.3b).
- *Gated.* If the programmable INTERVAL parameter is set to a non-zero time interval, the Snapshot Log records once when the setpoint condition initially occurs, and continue to record at the specified intervals during the entire time that the setpoint remains in an active condition (see Figure 8.4.3b). This effectively produces a *window* of snapshot records. Subsequent triggers causes successive windows of snapshot records to be stored. This method makes very efficient use of the snapshot memory, since logging occurs only during periods of interest.

Figure 8.4.3a M-SCADA Historical Trending Screen

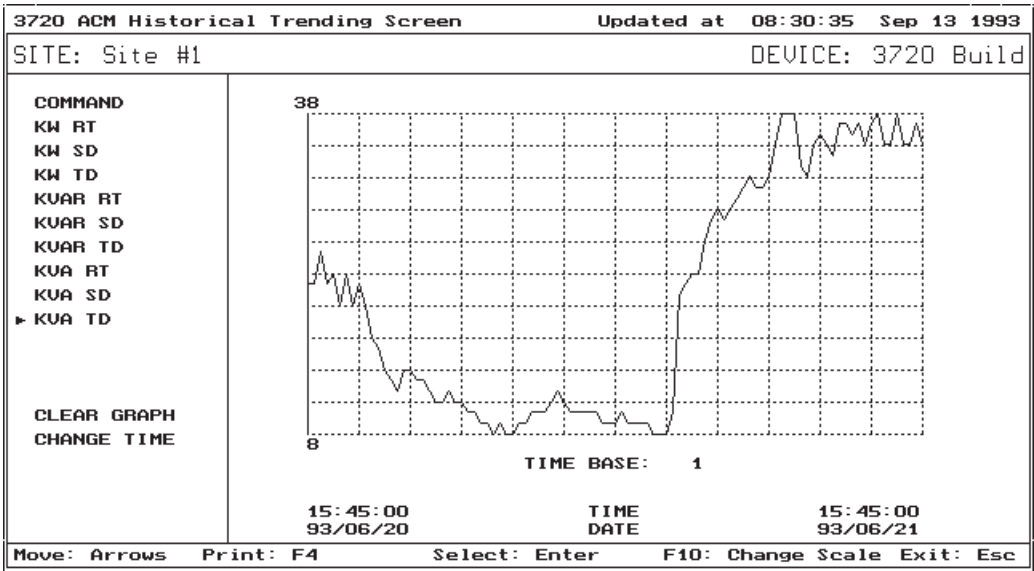
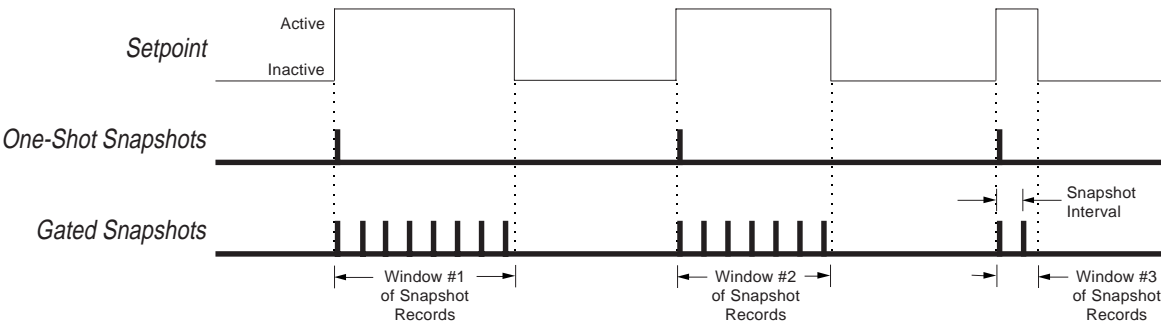


Figure 8.4.3b One-Shot vs. Gated Snapshot Logging



**NOTE**

Data recorded using a setpoint-triggered Snapshot Log is not suited for viewing using the *Historical Trending* feature in the SCADA software, since the stored records are not time-stamped at equal intervals.

**WRAP-AROUND**

For both interval and setpoint triggering, the internal logging function for a standard Snapshot Log fills all the available memory allocated for the log, then *wraps around* by writing new snapshot records over the earliest records in the memory.

Depending on the overall system bandwidth (i.e. number of remote devices, communication and polling methodologies, etc.), POWER MEASUREMENT's SCADA master station may not communicate with the remote 3720 ACM frequently enough that all new data is uploaded prior to being overwritten by wrap-around. This may also apply to any third-party system used. The system configuration must take this into account to ensure that critical data is not lost.

### 8.4.4 HIGH-SPEED SNAPSHOT LOG

#### NOTE

The High-Speed Snapshot Log (HSS) cannot be used concurrently with the Time-Overcurrent Curve (TOC) feature. Select which feature to enable by setting the HIGH SPEED FEATURE parameter via communications. This parameter must be set to HSS to enable the High-Speed Snapshot Log.

Snapshot Log 8 of the 3720 ACM can be configured as a *high-speed* log. The log can record 2-cycle (or greater) intervals, and is controlled by an additional user-defined *stop condition*. This log is ideal for analyzing short-term conditions such as motor start-up, system stability, or load switching response, etc.

#### Logged Parameters

The parameter recorded by each channel of a log is user-programmable. The values of any *high-speed* measured or status parameter can be logged. See Chapter 4 for a list of these parameters.

#### NOTE

For the high-speed log, if the meter is configured in DELTA mode, all high-speed phase voltage line-to-neutral parameters produce line-to-line values. Conversely, line-to-line values produce line-to-neutral values when operating in WYE mode.

#### Trigger

##### MANUAL

Manual triggering can be accomplished via communications using M-SCADA/L-SCADA† or any compatible third-party system.

To enable manual triggering, the TRIGGER TYPE parameter must be set to MANUAL. If the log has been set to SETPOINT (see below), manual triggering is not possible.

Logging can be performed in one of two ways:

- *Interval*  
The INTERVAL parameter should be set to any non-zero number. Interval values between 2 and 130,000 cycles (approx. 36 minutes) in 2 cycle increments are possible. Following the manual trigger command, logging is performed at the specified intervals until the defined stop condition is encountered (see Figure 8.4.4). LOG FULL or TIMED OUT stop conditions must be used (see below).

#### NOTE

The high-speed log will not run continuously. A stop condition must be defined.

- *One Shot*  
This mode causes the Snapshot Log to record *once* when the manual trigger command initially occurs (see Figure 8.4.4). This mode can be programmed in a number of ways.
  - Set the stop condition to TIMED OUT. Set the INTERVAL parameter to a value greater than the timeout period.
  - Set the stop condition to TIMED OUT or LOG FULL. Set the INTERVAL parameter to 0 (zero).

#### SETPPOINT

The log can also be triggered by a high-speed setpoint. Standard setpoints cannot be used.

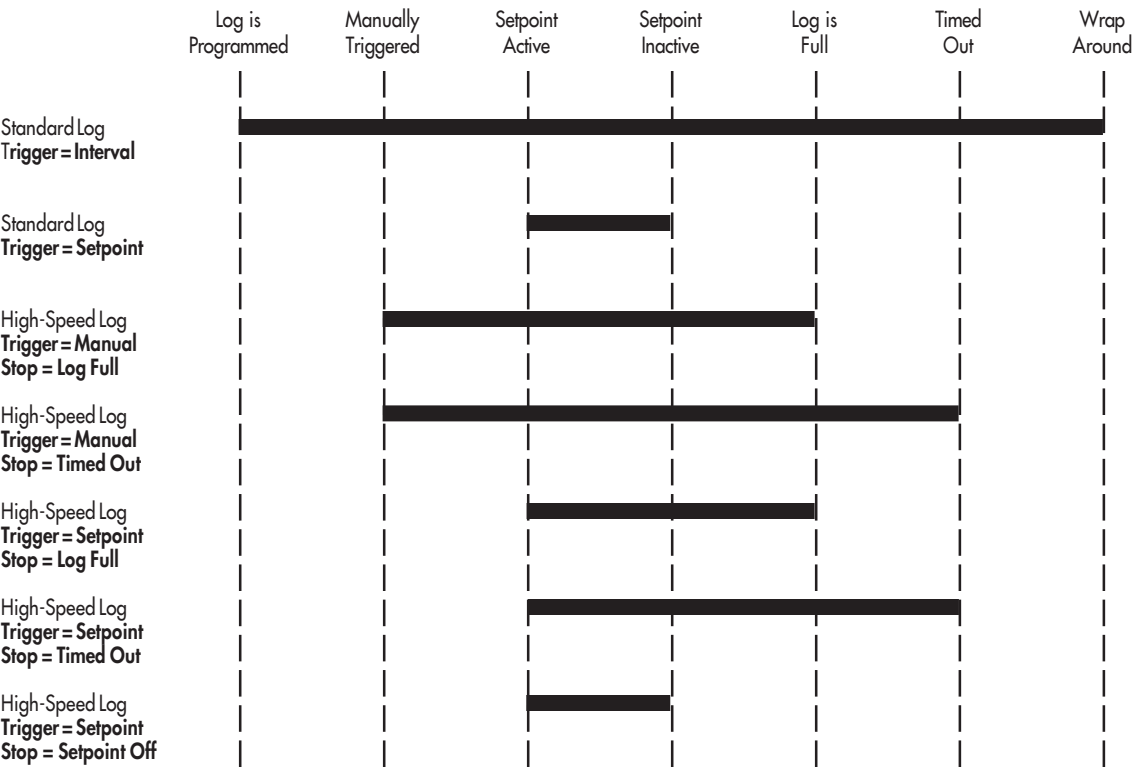
To enable setpoint triggering, the TRIGGER TYPE parameter must be set to SETPOINT. The ACTION1 or ACTION2 for the high-speed setpoint used must be configured as SNAP-SHOT 8 (high-speed log).

Logging can be performed in one of three ways:

- *Interval*  
Operation is similar to the interval mode described for manual triggering, except that an active setpoint condition triggers the log. LOG FULL or TIMED OUT stop conditions must be used (see below).
- *One Shot*  
Operation is similar to the one-shot mode described for manual triggering, except that an active setpoint condition triggers the log.
- *Gated*  
The programmable INTERVAL parameter must be set to a non-zero time interval. If the stop condition is set to SETPOINT OFF, the Snapshot Log records once when the setpoint condition initially occurs, and continues to record at the specified intervals during the entire time the setpoint remains in an active condition. Similar to gated logging with standard Snapshot Logs, this effectively produces a *window* of snapshot records (see Figure 8.4.3b). Subsequent triggers cause successive windows of snapshot records to be stored. If the data is not uploaded via communications, logging *wraps around*, writing new snapshot records over the earliest windows of records in the memory. Once uploaded, all previous data is cleared and the log is rearmed.

† M-SCADA / L-SCADA version 4.2 or later.

Figure 8.4.4 Snapshot Logging: Modes of Operation



**STOP CONDITION**

One of the following stop conditions must always be specified for manually or setpoint-triggered high-speed snapshot logging:

- **LOG FULL**  
Logging is stopped when all memory space designated for the log has been filled up. This stop condition can be used with manual or setpoint triggering.
- **TIMED OUT**  
Logging is stopped after a user-specified duration (in cycles) has passed. This stop condition can be used with manual or setpoint triggering. *DURATION* parameter is used to set the time out duration.
- **SETPOINT OFF**  
If the log is being triggered by a setpoint, logging is stopped when the setpoint goes inactive. This stop condition can be used only with setpoint triggering.

When the stop condition occurs, the log is frozen until the data is uploaded via communications. The SCADA software automatically senses when the log is ready to be uploaded. The system uploads all data and rearms the log. In all cases, no downloading can occur while the log is running.

**WRAP-AROUND**

There are only two cases when high-speed snapshot logging *wraps around* by writing new snapshot records over the earliest records in the memory. These are as follows:

- If triggering is **MANUAL** or **SETPOINT**, *interval* logging is used, the stop condition is **TIMED OUT**, and the *DURATION* is set higher than the time needed to fill the memory.
- Triggering is set to **SETPOINT**, *gated* logging is used by setting the stop condition to **SETPOINT OFF**, and the setpoint remains active for a duration longer than the time needed to fill the memory. Alternatively, repetitive setpoint triggers cause the log to wrap around prior to the data being uploaded.

The **LOG FULL** stop condition does not allow wrap-around to occur.

The SCADA software master station will not upload high-speed log data until the log is stopped by the defined stop condition. Ensure that critical data is not overwritten by wrap-around by selecting an appropriate stop condition for the application.

## 8.5 ACCESS TO LOGGED DATA

The Event, Min/Max, and Snapshot Logs of the 3720 ACM are stored on-board in non-volatile memory and are accessible via communications.

POWER MEASUREMENT's SCADA software, or any compatible third-party software, can be used to read this data. The SCADA software can also automatically archive to disk all logged data retrieved from each remote device on a schedule basis.

It provides a number of different options for displaying logged data, and can also convert logged data into formats compatible with a wide variety of third-party data base programs for further analysis.

## 8.6 TIME STAMP ACCURACY

Time stamps for 3720 ACM logged parameters have an internal resolution of 1 microsecond. When using the SCADA software to upload and display logged data, log records are displayed with time stamps of millisecond resolution.

The actual accuracy of the time stamp depends on the type of parameter being logged:

### RELAY, STATUS INPUT, WAVEFORM CAPTURE, & WAVEFORM RECORDER ACTIVITY

These items are logged with a time stamp accuracy of +/- 1 millisecond. The fast sensing and accurate time-stamping of the status inputs make them ideal for sequence-of-event recording using the Event Log.

### REAL-TIME MEASURED PARAMETERS

These measurements are updated once each second and therefore have a logged time stamp accuracy of +/- 1 second.

### HIGH-SPEED SETPOINTS

These use the internal high-speed measured parameters as trigger parameters, and therefore provide a time stamp accuracy of +/- 2 cycles.

### STANDARD SETPOINTS

These use the 1 second update measured parameters as trigger parameters, and therefore have a logged time accuracy of +/- 1 second.

## Meter-to-Meter Time Sync

Using the global time sync broadcast capability of the SCADA software, the on-board clocks of all 3720 ACM devices connected on the same RS-485 bus are time synchronized to a typical accuracy of  $\pm 1$  ms (max.  $\pm 10$  ms). This allows for 1 ms time-stamp accuracy on waveform capture and recorder data, and status input or relay activity in the Event Log.

### NOTE

1. Mechanical relay delay is not included in the above specification. As described in Section 6.2.2, this additional delay is typically between 8 and 15 milliseconds.
2. The on-board clock of the 3720 ACM is battery-backed, allowing the clock to continue to run, even in the event of a power failure.



## 9 COMMUNICATIONS

### 9.1 GENERAL

The 3720 ACM is equipped with a communications port which allows the 3720 ACM to be integrated within large energy monitoring networks. The communications port is optically isolated and transient protected. It is field-configurable for EIA RS-232 or RS-485 standards, and can operate at baud rates up to 19,200.

As an option, a Multiport Communications Cards (MPCC/MPE) are available. All ports on this card can communicate simultaneously and each port will operate with any of the supported communications protocols. For more information on the MPCC and MPE, see Section 2.6.3.

The communications port provides you with access to the advanced features of the 3720 ACM not available from the device's front panel. These include waveform capture and recording, data logging, and many of the setup parameters for the setpoint system and other features.

The 3720 ACM supports the following communication protocols:

- PML 3720
- Modicon Modbus
- AB DF-1 (MPCC v1.2.0.0. or MPE v2.2.0.0 or later )
- Alarm Dialer (MPCC v1.2.0.0. or MPE v2.2.0.0 or later)

The PML 3720 protocol is fully compatible with POWER MEASUREMENT's PC-based SCADA systems, and with the WinTOU Setup utility. The SCADA software can display all measured parameters and status information, waveform data, data logs, and Time-Of-Use registers provided by the 3720 ACM. The SCADA software can also be used to remotely program the setup parameters for all basic and advanced features. Programming of all TOU setup parameters must be performed using WinTOU Setup.

#### NOTE

If you are using the 3720 ACM with POWER MEASUREMENT's SCADA software, the PASSWORD PROTECT parameter must be set to NO (see page 3-11).

The open communications protocol of the 3720 ACM allows access to all data and setup parameters by third-party systems.

This chapter provides additional information regarding remote communications connections, programming, and general operation.

### 9.2 RS-232 COMMUNICATION

#### Direct Connection

RS-232 is commonly used for short distance, point-to-point communications. Connection between a host computer (or PLC) and a *single* remote device must be less than 50 feet. Figures 2.6.4a and 2.6.4b in Chapter 2 provide wiring diagrams for direct RS-232 connection and the required wiring for the RS-232 interconnect cable(s).

#### Modem Connection

Connection using modems via dedicated or dial-up telephone lines is also possible (see Figure 9.2.1).

When using a modem, it is important that the computer-to-modem and modem-to-POWER MEASUREMENT device cable connections illustrated in Figure 2.6.4b in Chapter 2 are used.

#### Using the RTS & CTS Lines

The RS-232 port RTS line is operational for both the ISOCOM2 card and the MPCC/MPE cards (see Chapter 2) and can be used, if required, with any hardware device connected to the 3720 ACM. POWER MEASUREMENT's SCADA systems do not require the use of the RTS line for direct RS-232 connections; however, some types of modems (i.e. radio modems) may require its operation.

The RTS signal is asserted before the beginning of a transmission and remains asserted throughout the transmission. The time delay between the assertion of the RTS and the start of the transmission is controlled by the TRANSMIT DELAY parameter, which can be set from the front panel. The range is 0 to 999 ms (with a default of 20 ms).

The programmable RTS ACTIVE LVL parameter selects whether the RTS line is asserted HIGH or LOW during transmission.

CTS is available only on the optional Multi-Port Communication Cards (MPCC/MPE). CTS must be asserted before port A can transmit.

#### Carrier Detect

Carrier Detect (CD) is available only on the optional Multi-Port Communications Cards (MPCC/MPE). Carrier detect is specifically designed for use when a DCE device (i.e. modem) is connected. With CD enabled, transmit will not occur until CD is asserted by a modem. To enable the Carrier Detect function, the 3720 ACM must be programmed so that CARRIER DETECT = YES. For the MPCC and MPE, CARRIER DETECT replaces the COMM MODE parameter in programming mode. Refer to Chapter 3, Figure 3.4.6c, Communications Group.



### 9.3 RS-485 COMMUNICATION

RS-485 is used when multiple devices are installed at a remote site. RS-485 communication can be used to concurrently connect up to thirty-two remote devices on a single communications loop. Each device is given a unique **UNIT ID** (identification number). In this way, each remote device may be monitored and controlled from one location by a single computer/PLC.

The total distance limitation on a single RS-485 communication network is 4000 ft./1200 m using AWG 22 twisted pair shielded cable. Figure 2.6.5b in Chapter 2 provides a wiring diagram for RS-485 network connection.

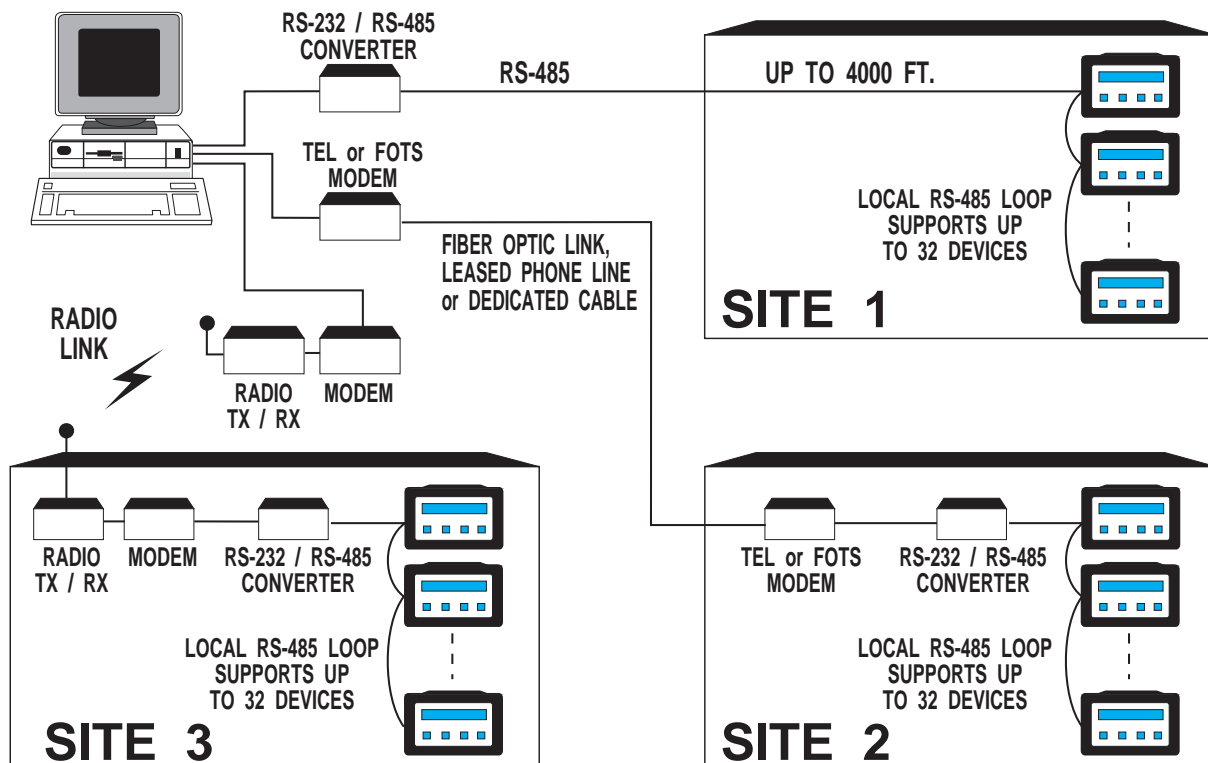
Communication methods between the remote RS-485 site and the master computer station can include a direct RS-485 connection (under 4000 ft./1200 m), telephone lines with modems, fibre-optic and/or radio links. An RS-232 to RS-485 converter, such as POWER MEASUREMENT's COM32 or COM128, is required between the RS-232 port of the computer or modem and the RS-485 network (see Chapter 2, Figure 2.6.5b).

### 9.4 SETTING THE UNIT ID & BAUD RATE

Before communication with the host computer/PLC is possible, ensure that the 3720 ACM, and all other connected devices, are configured for the required communications standard (RS-232 or RS-485). Instructions for 3720 ACM communication card configuration are provided in Chapter 2, Section 2.6.2.

The next step is to program the communication parameters of the 3720 ACM, and all other connected devices. The **UNIT ID** and **BAUD RATE** parameters of the 3720 ACM can be programmed via the front panel. The **UNIT ID** must be set to a unique value between 1 and 9999. The **BAUD RATE** of each device on the network must be set to correspond with the baud rate selected for the computer. Options include 300, 1200, 2400, 4800, 9600 or 19,200 bps. Baud rates up to 115,200 bps are available using the MPCC and MPE.

Figure 9.2.1 Remote Communication Methods



**CAUTION**

When using a modem interface between the host computer and any remote device(s), ensure that the host computer is not used to set the BAUD RATE parameter of any selected device outside the working range of the modem. Doing so will cause that meter to cease communicating. Re-establishing communication with that meter is then only possible through performing the following:

1. Reset the baud rate of the remote device from its front panel to a value within the working range of the modem.
2. Set the computer to communicate at the baud rate at which the remote device has been set to communicate.

## 9.5 3720 ACM TRAN MODEL OPERATION

The TRAN version of the 3720 ACM provides all the functions of the 3720 ACM, except that it has no front panel display or keypad. All measured parameters, status information, and programming parameters are accessed via communications.

To initiate communications with the device, the factory-set UNIT ID and BAUD RATE must be used:

### UNIT ID

This is set at the factory to be the last 4 digits of the unit's serial number, which can be found on the rear cover of the unit. For example, a unit with serial number 71317 will be preset to UNIT ID of 1317.

### BAUD RATE

This is set at the factory to 9600 baud.

Once communication has been established using the factory defaults, the device's operating parameters may be changed using the remote computer. You may also reset the UNIT ID of the device to any other desired value, as well as resetting the BAUD RATE. Refer to Section 9.4 for important information regarding resetting the BAUD RATE.

## 9.6 POWER MEASUREMENT'S SCADA SYSTEM

The 3720 ACM maintains compatibility with POWER MEASUREMENT's PC-based power monitoring software packages, M-SCADA, L-SCADA, PowerView, and entire family of 3000 series digital instrumentation, which includes power meters, power demand controllers, and smart transducer interfaces. A single M-SCADA station can support up to 99 remote sites with a total of 3168 devices. L-SCADA supports 12 sites with a total of 12 devices. Systems are easily expandable.

The SCADA software provides extensive full-color data display options, automated data handling and system control features including:

- Real-time data display for all or part of the power system. Full color, user-configurable *system diagrams* can be used to give a system-wide display of power conditions. Real-time and logged data for individual devices can also be viewed.
- Display of captured waveforms and harmonic analysis. The 3720 ACM provides on-board harmonic analysis to the 15th harmonic. The SCADA software can provide more detailed power quality analysis to the 63rd harmonic in graphical or tabular formats.
- Display of 12-cycle waveform recorder data. Waveforms for all inputs can be displayed concurrently on the screen for fault or surge/sag analysis.
- Historical trend graphing. The SCADA software can display historical, time-interval triggered Snapshot Log data in graphical format.
- Detection, annunciation, display and logging of alarm conditions.
- Automatic retrieval and disk archival of data logs from remote devices.
- Manual control of the on-board relays of all POWER MEASUREMENT devices.
- Remote programming of the setup parameters of all POWER MEASUREMENT devices.

POWER MEASUREMENT's proven *distributed processing* approach to power monitoring guarantees consistently accurate data retrieval by delegating extensive data acquisition, data logging, and control capabilities to the remote meter/RTU sites. Less processing requirements at the master station means high reliability and performance. Non-volatile data logs ensure data is always retrievable following a temporary power or communication failure.

Contact POWER MEASUREMENT or your local POWER MEASUREMENT representative for detailed information on the SCADA system and the complete range of POWER MEASUREMENT instrumentation and PC-based software products.

## 9.7 THIRD-PARTY SYSTEM COMPATIBILITY

3720 ACM communications uses an advanced object and register based open protocol which supports an efficient exception reporting methodology. This allows the 3720 ACM to be easily adapted to third-party PLC, DCS, EMS, and SCADA systems.

All data and configuration registers are accessible via communications. All configuration and control operations have embedded password protection.

Contact POWER MEASUREMENT or your local POWER MEASUREMENT representative for complete documentation on the 3720 ACM communications protocol, or to discuss a specific application.

## 9.8 MODBUS PROTOCOL

The 3720 ACM provides compatibility with the *Modicon MODBUS* system. The Modbus communications protocol allows information and data to be efficiently transferred between a Modicon Programmable Controller and a 3720 ACM. The 3720 ACM performs Modbus communications by emulating a Modicon 984 Controller.

All 3720 ACM measured data can be accessed, including all real-time and demand values (kW, Amps or kVA). Polarity of power measurements can be determined through polarity registers.

All values from all Preset Minimum/Maximum Logs and all entries in the Event Log are also accessible, including individual time stamps. The contents of the Snapshot Logs or Wave Recorder Logs are not available.

The condition of each of the four status inputs and three relays can be read. The relays may also be controlled manually via communications.

The protocol also provides commands to initiate waveform capture and to read the sampled waveform data.

All setup parameters can be read and/or configured, including setpoint and relay setup. Optional password protection is also provided.

The Modbus protocol supports standard 16 bit, as well as 32 bit extended registers. 32 bit registers would typically be required only for large energy values (i.e. KWH, etc.).

### NOTE

The Modbus protocol is not compatible with POWER MEASUREMENT's SCADA software.

Modbus RTU protocol is used over Ethernet on the optional MPE communications card.

### 9.8.1 HARDWARE REQUIREMENTS AND WIRING

A Modicon BM85 Bridge/Multiplexer is required between the Modbus and Modicon Controller. An RS-232 to RS-485 converter may also be required. This is described below.

#### Single Drop

A *single drop* topology allows one 3720 ACM to be interfaced directly to the Modbus via its RS-232 port. Up to four 3720 ACMs may be connected to each BM85, one to each port of

the Bridge/Mux. A custom cable is required between the BM85 and the 3720 ACM (see Figure 9.8.1).

#### Multi-Drop

A *multi-drop* topology allows up to thirty-two 3720 ACMs to be connected to each of the four BM85 Bridge/Mux ports. The RS-485 port of each 3720 ACM is connected on an RS-485 network that is interfaced to the Modbus via an RS-232 to RS-485 converter, such as POWER MEASUREMENT's COM32™ or COM128™. This allows for up to 128 power meters to be connected to each BM85 (see Figure 9.8.1). The cable connecting the Bridge/Mux to the converter is a 9-pin male to 25-pin male serial cable. Refer to Section 2.6.5 for RS-485 network connections.

### 9.8.2 SETTING COMMUNICATIONS PARAMETERS

When using Modbus communications, the range of possible UNIT ID designations for the 3720 ACM must be between 1 and 247.

The COM MODE parameter should be set according to the communications topology being used (RS-232 for single, RS-485 for multi-drop).

The Modbus protocol setup provides two additional parameters:

- REGISTER SIZE  
This determines whether a 16-bit (16B) or an extended 32-bit (32B) register is passed in communications for each function. The default setting is 16B.
- INVALID OBJECTS  
This specifies whether or not the 3720 ACM returns a value for an invalid object. The options are YES or NO. If YES is selected, the 3720 ACM will return a value of either 0 or 0xFFFF for an invalid object.

### 9.8.3 COMMUNICATIONS PROTOCOL

Communications occurs from the Controller via the Modbus Plus network (using MSTR block), across the BM85 to the Modbus, and on to the 3720 ACM(s) via the RS-232 / RS-485 converter (multi-drop only).

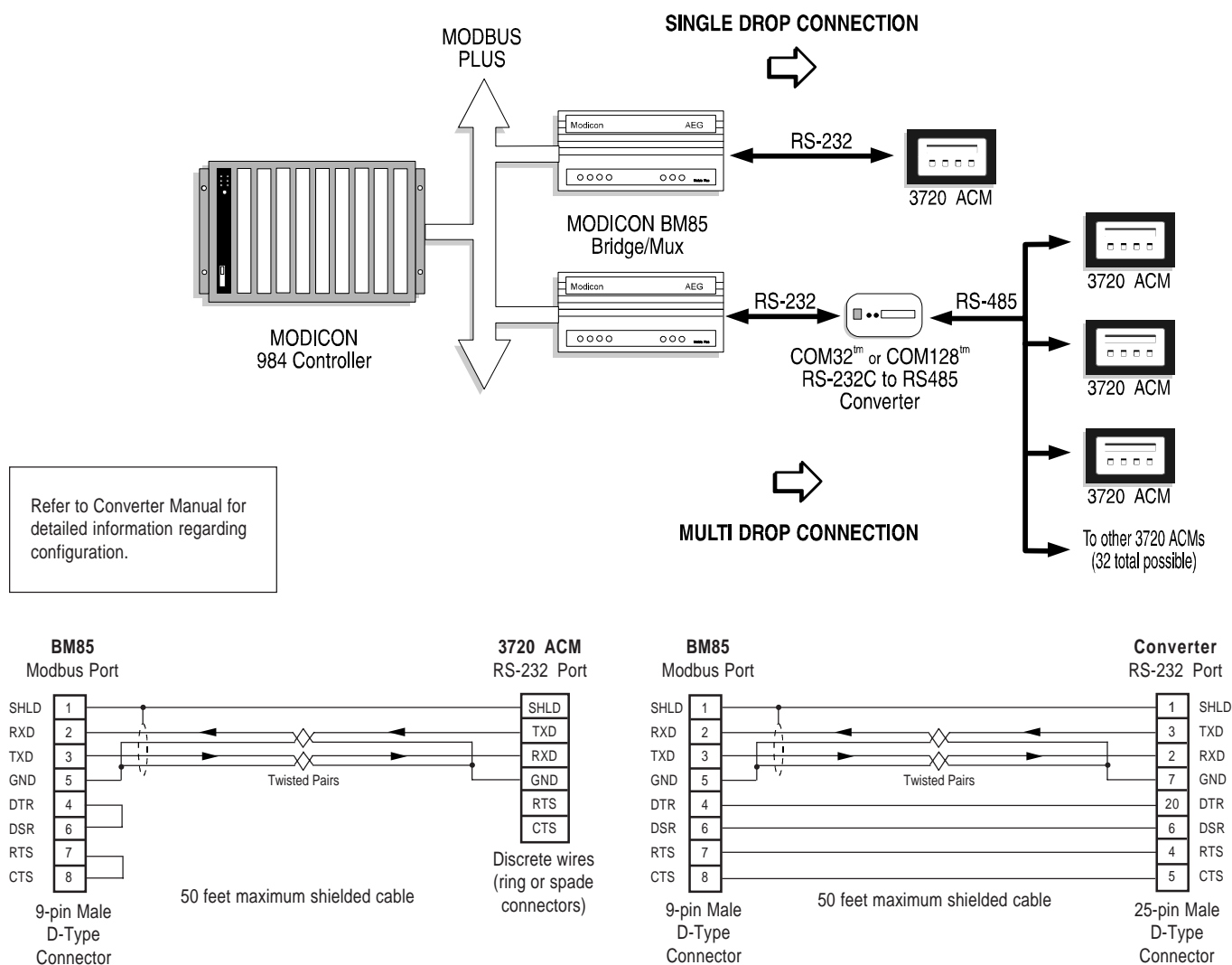
All communications between the BM85 and 3720 ACM(s) conform to a *master/slave* scheme with the BM85 as the master and the 3720 ACM(s) as slave(s).

#### Message Packets Supported

All registers within the 3720 ACM are accessible as PLC 4xxxx holding registers. The following Modbus commands are supported:

#### PRESET MULTIPLE REGISTERS (10H)

allows the Modicon Controller to define all the user-programmable setup parameters in the 3720 ACM. Registers are also provided to allow the Controller to clear the energy consumption (kWh, kVAh, kVARh) and status input counters of the 3720 ACM.

**Figure 9.8.1**     **Modbus Single and Multi-Drop Connections****READ HOLDING REGISTERS (03H)**

allows the controller to read 16-bit or 32-bit real-time measured data or setup parameters from the 3720 ACM. The status of the status inputs and relays may be read, and the relays manually controlled. Registers are also provided to allow the initiation of waveform capture, and the subsequent reading of waveform capture data.

For further information regarding operation with the Modicon Modbus communications protocol, refer to the POWER MEASUREMENT document:

*3720 ACM / MODICON MODBUS  
SERIAL COMMUNICATIONS PROTOCOL*

## 9.9 ALLEN BRADLEY DF-1 PROTOCOL

The Allen Bradley DF-1 protocol for the 3720 ACM-MPCC/MPE provides compatibility with Allen Bradley PLC devices and access to the *Allen-Bradley Data Highway Plus* (and *Data Highway*). See Figure 9.9.1. The Allen Bradley (AB) Full Duplex DF-1 protocol allows information to be transferred easily between an AB Programmable Logic Control (PLC) and a 3720 ACM-MPCC/MPE. The 3720 ACM performs the communications by emulating an AB PLC-5. The 3720 ACM-MPCC/MPE implements two commands from the PLC-5 command set: Typed Read and Typed Write. The AB DF-1 protocol allows data to be efficiently transferred between an AB PLC and a 3720 ACM-MPCC/MPE.

All 3720 measured data can be accessed, including all real-time and demand values. All values from the Preset Min/Max Logs, with their respected timestamps, are also available. Contents of the Snapshot Logs and Event Log are not available. The condition of all four status inputs and three relays can be read. The relays can also be controlled manually through communications. The AB DF-1 protocol also provides commands to initiate a waveform capture of a single channel and a waveform recorder of all eight channels. The sampled waveform data can then be downloaded for analysis. All setup parameters can be read and/or configured including the relay setup. The Snapshot Log and Setpoint Setup cannot currently be configured. The AB DF-1 protocol supports standard 16-bit, as well as 32 bit extended registers. The 32-bit registers are typically only required to read large real-time values and possibly in configuring certain registers.

### 9.9.1 HARDWARE REQUIREMENTS AND WIRING

The 3720 ACM-MPCC/MPE interfaces to the Data Highway via two Allen-Bradley Communication Interface Modules - the 1770-KF2 *Series B Communication Interface Module* and the 1785-KE *Series B Data Highway Plus RS-232-C Communications Module*.

#### Single Drop

A *single drop* communications topology allows one 3720 ACM-MPCC/MPE to be connected to the data highway via an AB communication interface module using RS-232 communications. A direct RS-232 connection is made between the AB interface module and the 3720 ACM-MPCC/MPE (See Figure 9.9.1).

#### Multi-Drop

A *multi-drop* communications topology allows you to connect up to 32 - 3720 ACM-MPCC/MPEs to the data highway via one AB communications interface module using RS-485 communications. A POWER MEASUREMENT COM32 or COM128 RS-232 to RS-485 Converter is required for multi-drop systems (See Figure 9.9.1).

## 9.9.2 COMMUNICATIONS PROTOCOL

All communications between the PLC and the 3720 ACM-MPCC/MPE(s) conform to a *master/slave* scheme. Information is transferred between a master PLC and slave 3720 ACM-MPCC/MPE(s). Communications occur from the PLC (using a MSG block) to the 3720 ACM-MPCC/MPE(s) via the RS-232/RS-485 converter (multi-drop only).

### Communication Parameters

When using the AB DF-1 protocol, the range of possible UNIT ID designations for the 3720 ACM must be between 1 and 99.

The Allen-Bradley protocol setup provides an additional parameter - Register Size. This determines whether a 16-bit or an extended 32-bit register is passed in communications for each request. The default setting is 16-bit.

### Message Packets Supported

The following message packets are supported:

#### PLC-5 TYPED READ (READ BLOCK)

allows the PLC to read 16-bit or 32-bit real-time measured data or setup parameters from the 3720 ACM-MPCC/MPE. The status of the status inputs or relays may be read. The downloading of the Waveform Capture Log and the Waveform Recorder Log are supported.

#### PLC-5 TYPED WRITE (WRITE BLOCK)

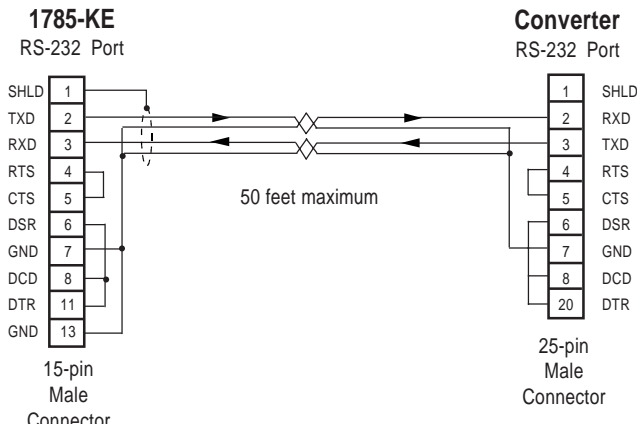
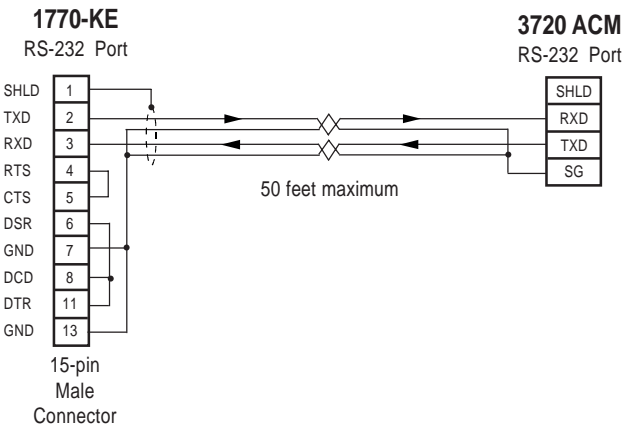
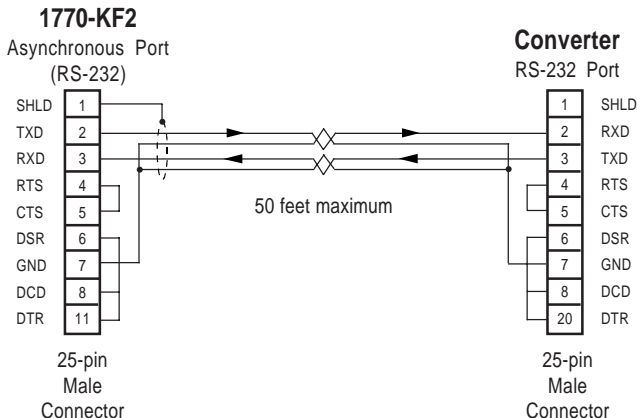
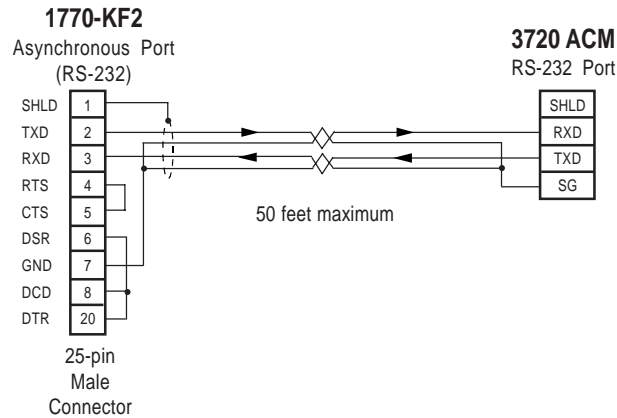
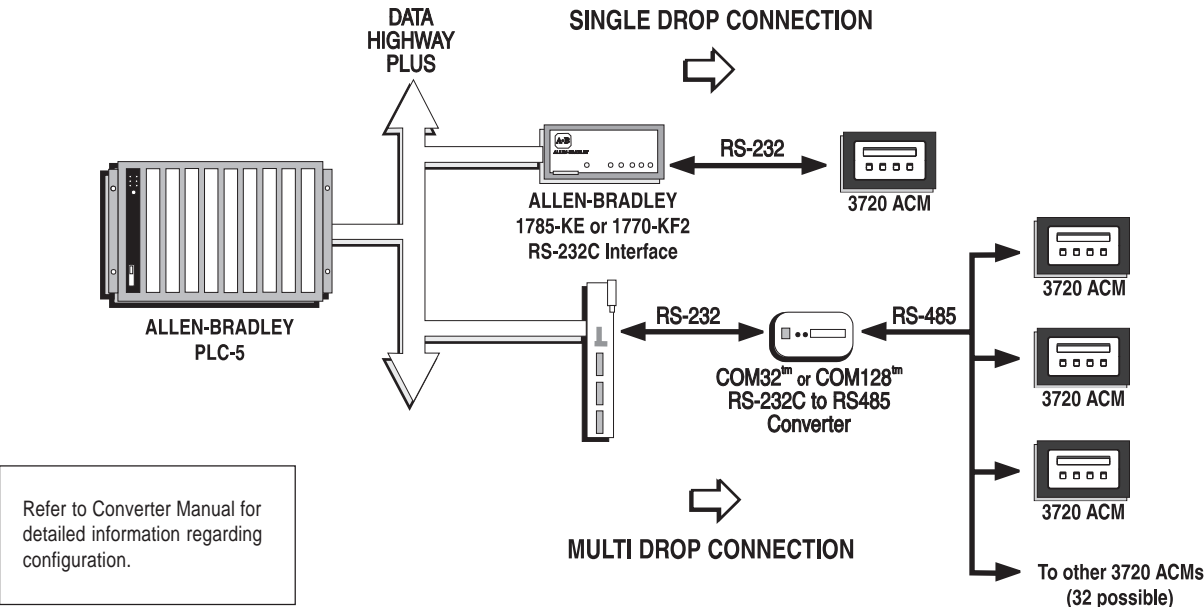
allows the AB PLC to define all the user-programmable setup parameters in the 3720 ACM-MPCC/MPE with the exception of the setpoint and snapshot log configuration. Registers are also provided to allow the PLC to control the relays and clear the Preset Minimum/Maximum Logs, energy consumption registers and the status input counters of the 3720 ACM.

For more information regarding operation with AB communications protocol, refer to the POWER MEASUREMENT document:

*3720 ACM-MPCC ALLEN-BRADLEY DF-1  
SERIAL COMMUNICATIONS PROTOCOL*



Figure 9.9.1 Allen Bradley Single and Multi-Drop Connections



## 9.10 ALARM DIALER PROTOCOL

The 3720 ACM-MPCC/MPE Alarm Dialer is used to initiate communications and send alarms from remote sites in response to preconfigured alarm conditions. The Alarm Dialer can be used to contact PEGASYS stations or send information to remote terminals and printers. This allows the annunciation of alarms occurring at remote sites that are not equipped with PEGASYS.

### 9.10.1 HARDWARE REQUIREMENTS AND WIRING

The Alarm Dialer protocol can be configured to run on any or all of the ports on the 3720 ACM-MPCC/MPE.

Only one MPCC/MPE Alarm Dialer can be used on a network of devices. Other devices can monitor alarm conditions and communicate to the Alarm Dialer, provided these other devices have the ability to output a digital signal. In this application, the devices monitoring the alarm conditions send pulses to the 3720 ACM-MPCC/MPE Alarm Dialer, which in turn initiates communication and dials out the alarm. In order to transmit pulses between devices, control wiring must be installed, and the 3720ACM with the Alarm Dialer must be properly configured. If you require dial-out of alarms that originate on other devices in the network, contact POWER MEASUREMENT Customer Service for assistance configuring your system.

#### NOTE

When alarm conditions occur, the Alarm Dialer listens for communications traffic on the network. If other communications are in progress, the Alarm Dialer deactivates and waits for the other communications to complete. Only alarms that are processed when the network is quiet will dial-out successfully.

### RS-232 Connection

A direct connection can be made between the 3720ACM-MPCC/MPE's RS-232 port and the modem.

### RS-485 Connection

Either of the MPCC/MPE's RS-485 ports can be used with the Alarm Dialer. The RS-485 bus that the Alarm Dialer is configured on must be connected to the modem (an RS-232 to RS-485 converter, such as POWER MEASUREMENT's COM128, is required).

### 9.10.2 CONFIGURATION

The Alarm Dialer is configured using PowerView for Windows, available from POWER MEASUREMENT.

A total of 10 phone numbers can be configured for the Alarm Dialer (10 numbers total for all ports combined). Phone numbers cannot be shared between MPCC/MPE ports.

Configuration of the MPCC/MPE ports requires direct connection: you must configure the Alarm Dialer parameters while connected to the port you want to use for dial-out. If you intend to use multiple ports, connect to each port to configure its Alarm Dialer parameters.

Refer to the on-line help available in PowerView for Windows for configuration information.

### Alarm Conditions

Each phone number can have up to 12 different alarm conditions trigger a dial-out. Valid alarm conditions include status inputs, high-speed setpoints or normal setpoints going active, inactive, or changing state. Each alarm condition also has a priority associated with it. When the phone number is called, the highest priority alarm currently active for that number will be sent to the remote system. Multiple stations can be called for a single alarm.

### Modem Support

The Alarm Dialer does not directly support any particular modem. To allow compatibility with a wide variety of modems, the modem initialization string and dialer string for each phone number is fully configurable using Wmodem, a utility available from POWER MEASUREMENT.

For more information regarding the AD protocol, refer to the POWER MEASUREMENT document:

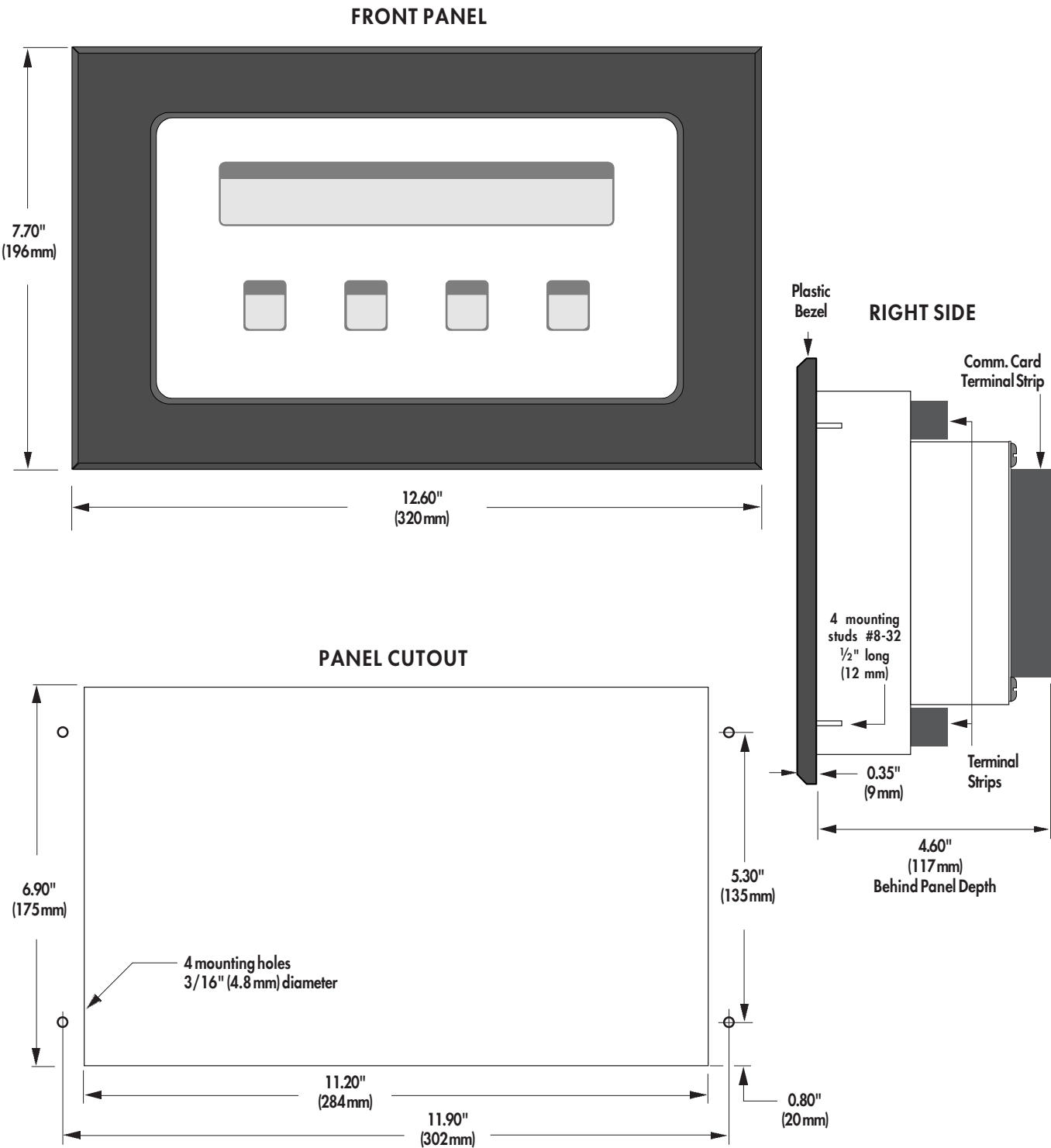
*3720 ACM  
SERIAL COMMUNICATIONS PROTOCOL*



APPENDIX A

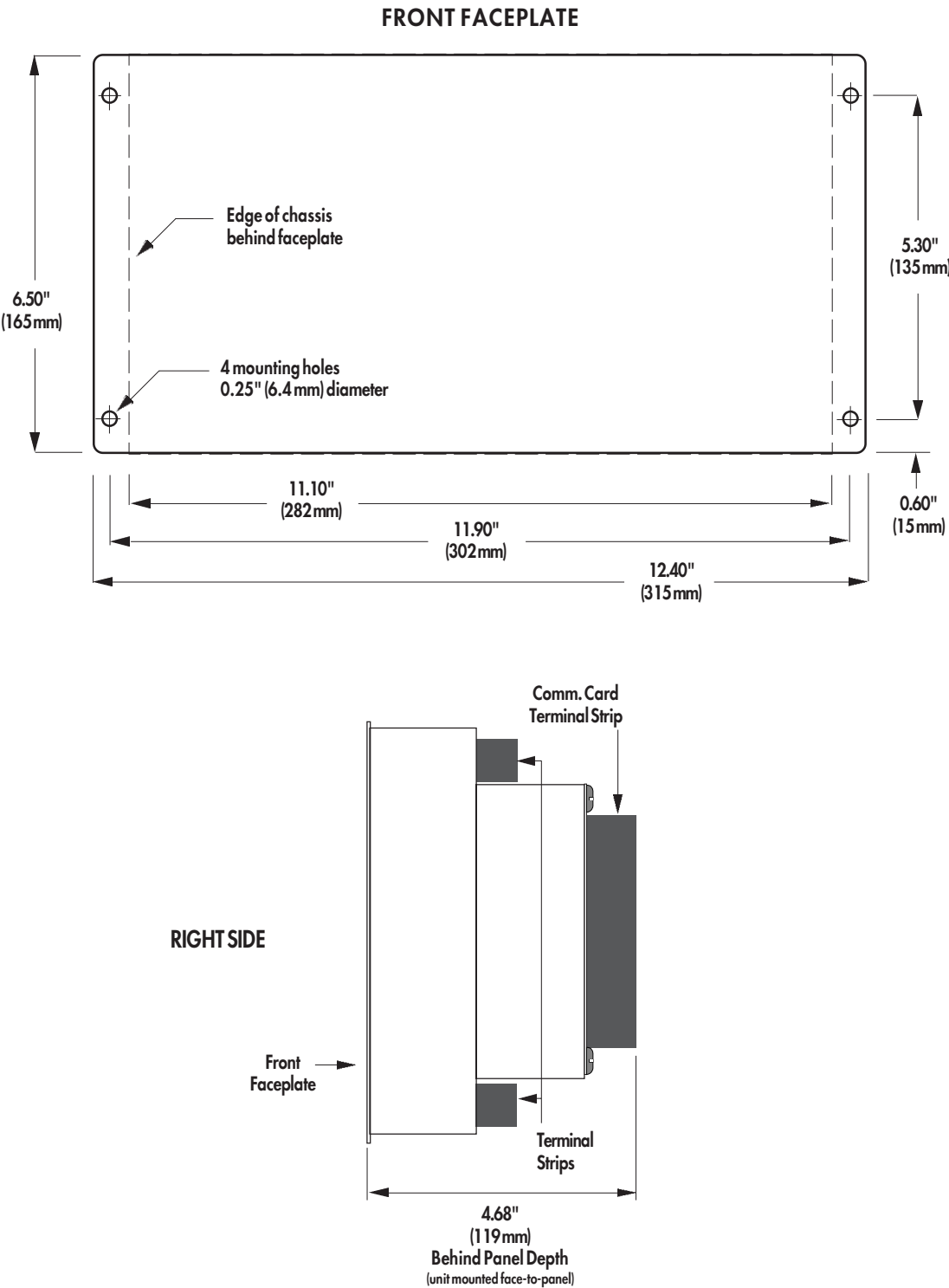
MECHANICAL & MOUNTING DIMENSIONS

BASIC MODEL



MECHANICAL & MOUNTING DIMENSIONS

TRAN MODEL

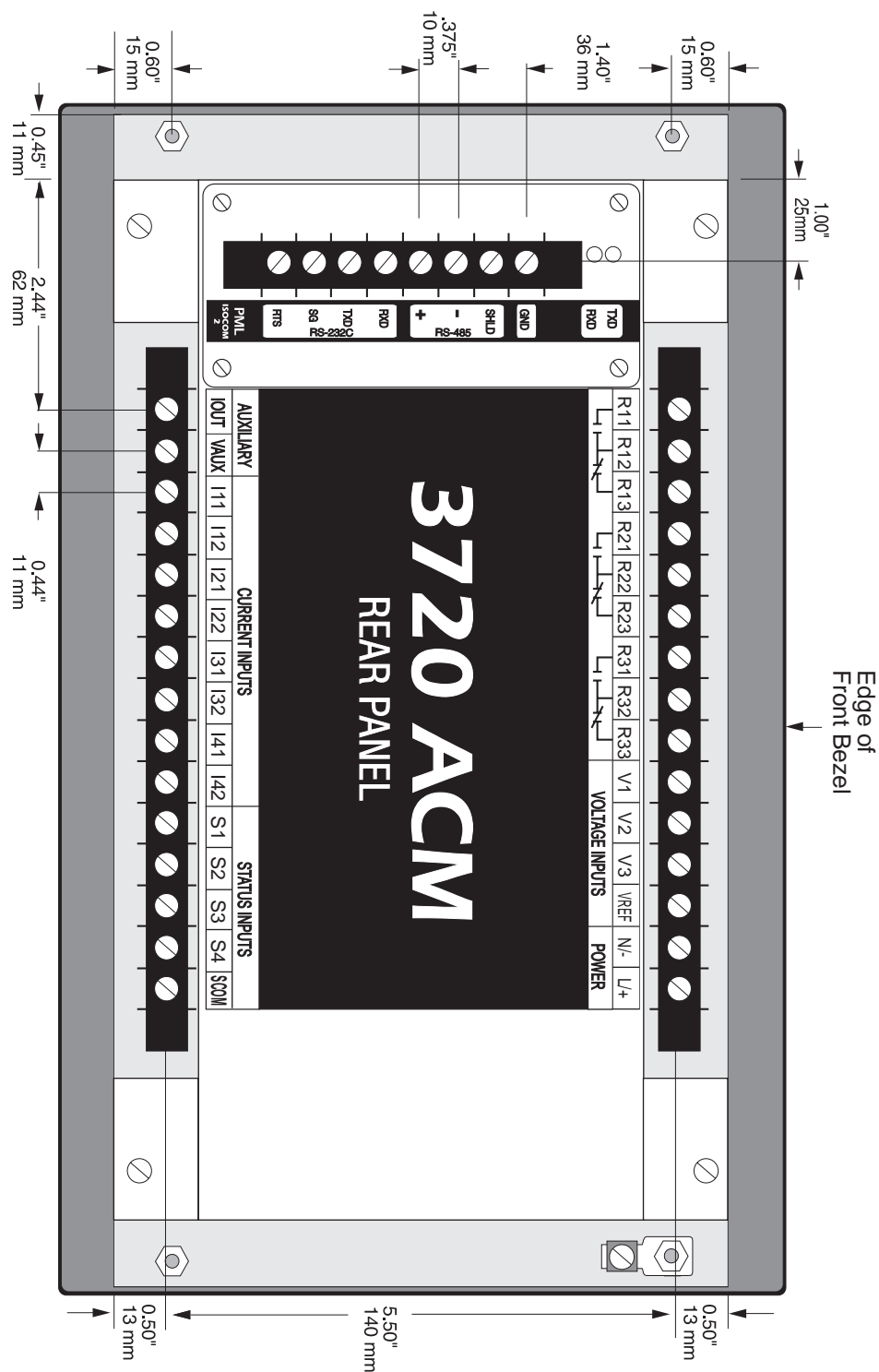


## MECHANICAL & MOUNTING DIMENSIONS

## REAR PANEL

## NOTE

Rear panel of basic model is shown. For TRAN model, disregard edge of front bezel.





**APPENDIX B****SETPOINT PARAMETER FORM****Standard Setpoints**

SETPOINT	TRIGGER PARAMETER	HIGH LIMIT	LOW LIMIT	TD OPERATE	TD RELEASE	ACTION1	ACTION2
S01							
S02							
S03							
S04							
S05							
S06							
S07							
S08							
S09							
S10							
S11							

**High Speed Setpoints**

SETPOINT	TRIGGER PARAMETER	HIGH LIMIT	LOW LIMIT	TD OPERATE	TD RELEASE	ACTION1	ACTION2
H01							
H02							
H03							
H04							
H05							
H06							



## APPENDIX C

### FIRMWARE VERSIONS

The following table lists each firmware version release for the 3720 ACM and the new features or performance enhancements added with each release.

The version number can be viewed from the front panel in Programming Mode. If your 3720 ACM is currently using a firmware version older than the most recent version listed in the table below, you may upgrade the firmware in that unit by contacting your local representative or the manufacturer.

Either contact will need to know the serial number of the 3720 ACM and the firmware version number indicated on the rear cover label.

Most upgrades to the 3720 ACM require a simple replacement of the EPROM (integrated circuit "chip") inside the unit which contains the operating firmware. Complete instructions for this procedure are provided with the replacement EPROM.

VERSION	RELEASE DATE	DESCRIPTION
V 1.1.1.X	July 1993	Initial release.
V1.2.X.X	January 1994	Adds K-Factor and predictive demand measurements. Adds TOU registers. Expanded waveform recorder, selectable 3 x 12-cycle, 2 x 18-cycle, or 1 x 36-cycle storage. Adds setpoint-triggered waveform capture. Adds meter-to-meter time sync capability. Adds high-speed snapshot log. Status input counters now scalable. Additional setpoint actions and high-speed parameters.
V1.3.X.X	August 1994	Adds independent thermal demand period (THERMAL PERIOD). Adds independent demand synchronization parameter (DEMAND SYN). Thermal constant redefined as the time required to reach 90% of registration. Adds automatic daylight savings time support. Adds high-speed frequency measurements. Modicon Modbus protocol supported.
V 1.4.X.X	August 1995	Support for V 0.0.0.5 of the MPCC.
V 1.5.X.X	March 1996	Support for V 1.X.X.X of the MPCC and V2.X.X.X of the MPE. Waveform recorder support through Modbus protocol. Adds secondary volt/amp measurements.





## APPENDIX D

## TECHNICAL SPECIFICATIONS

PARAMETER	ACCURACY (% of full scale)				FRONT PANEL DISPLAY	
	Basic	XAMPS	YAMPS	ZAMPS	Resolution	Range
<b>Current</b>	0.2 %	0.3 %	0.8 %	2.0 %	0.1 %	0 - 30,000
<b>Current Unbalance</b>	1.0 %	1.0 %	2.0 %	5.0 %	1.0 %	0 - 100 %
<b>kW</b>	0.4 %	0.5 %	1.0 %	2.5 %	0.1 %	0 - 999,999 <sup>2</sup>
<b>kVAR</b>	0.4 %	0.5 %	1.0 %	2.5 %	0.1 %	0 - 999,999 <sup>2</sup>
<b>kVA</b>	0.4 %	0.5 %	1.0 %	2.5 %	0.1 %	0 - 999,999 <sup>2</sup>
<b>kWh</b>	0.4 %	0.5 %	1.0 %	2.5 %	1 KWH	0 - 999,999,999
<b>kVARh</b>	0.4 %	0.5 %	1.0 %	2.5 %	1 KVARH	0 - 999,999,999
<b>kVAh</b>	0.4 %	0.5 %	1.0 %	2.5 %	1 KVAH	0 - 999,999,999
<b>Voltage</b>	0.2 %				0.1 %	0 - 999,999 <sup>1</sup>
<b>Voltage Unbalance</b>	1.0 %				1.0 %	0 - 100 %
<b>Power Factor</b>	1.0 %				1.0 %	- 0.6 to 1.0 to +0.6
<b>Frequency</b>	0.05 Hz				0.01 Hz	20.00 to 75.00 Hz
<b>Harmonic Distortion</b>	1.0 %				0.1 %	0.0 to 1000.0 %
<b>K-Factor</b>	10.0 %				0.1	1.0 to 9999.9
<b>I4</b>	0.2 %	0.3 %	0.8 %	2.0 %	0.1 %	0 - 9,999
<b>Vaux</b>	0.25 %				0.1 %	0 - 999,999

1. Reads in kV for voltages over 9,999
2. Reads in MVA, MW, MVAR for readings over 9,999k
3. For -XTEMP option derate accuracy by 0.01%/°C below 0°C and above 50°C

CURRENT OVERRANGE OPTIONS					
Option	Accuracy		Current Input Overrange		
	Amps	Power	% Full Scale	Amps	
				Basic	1AMP
Basic	0.2 %	0.4 %	125%	6.25	1.25
XAMPS	0.3 %	0.5 %	200%	10.00	2.00
YAMPS	0.8 %	1.0 %	500%	25.00	5.00
ZAMPS	2.0 %	2.5 %	1000%	50.00	10.00

WAVEFORM CAPTURE & RECORDING
<b>Waveform Capture</b> Sampling Rate: approximately 128 times per cycle Sampling Accuracy: 2% of full scale Resolution: 10 bits (0.1 %)
<b>Waveform Recording</b> Sampling Rate: approximately 16 times per cycle Sampling Accuracy: 2% of full scale Resolution: 10 bits (0.1 %)

## APPENDIX D TECHNICAL SPECIFICATIONS

### INPUT & OUTPUT RATINGS

<b>Voltage Inputs:</b>	Basic Model: 120 VAC nominal full scale input. 277 Option: 277 VAC nominal full scale input. 347 Option: 347 VAC nominal full scale input. Overload withstand for all options: 1500 VAC continuous, 2500 VAC for 1 second. Input impedance for all options: 2 Megohm
<b>Current Inputs:</b>	Basic Model: 5.000 Amps AC nominal full scale input. 1AMP Option: 1.000 Amp AC nominal full scale. Overload withstand for all options: 15 Amps continuous, 300 Amps for 1 sec. Input impedance: 0.002 ohm, Burden: 0.05 VA
<b>Aux. Voltage Input:</b>	1.0 VAC/VDC nominal full scale input (1.25 VAC /VDC max.) Overload withstand: 120 VAC/VDC continuous, 1000 VAC/VDC for 1 second. Input impedance: 10 Kohm
<b>Control Relays:</b>	Basic Model: Form C dry contact. 277 VAC / 30 VDC @ 10 Amp resistive SSR Option: SPST solid state. 24 to 280 VAC (use AC only) @ 1 Amp resistive
<b>Aux. Current Output:</b>	0 to 20 mA into max. 250 ohm load. Accuracy: 2%
<b>Status Inputs:</b>	+30 VDC differential SCOM output to S1, S2, S3, or S4 input. Min. Pulse Width: 40 msec.
<b>Power Supply:</b>	Basic Model: 100 to 240 VAC $\pm$ 10% / 47 to 440 Hz 110 to 300 VDC $\pm$ 10% P24/48 Option: 20 to 60 VDC @ 15W Includes a 250V, 2A time-lag Type T fuse on the L/+ terminal.
<b>Operating Temperature:</b>	Basic Model: 0°C to 50°C (32°F to 122°F) ambient air. XTEMP Option: -20°C to +70°C (-4°F to +158°F)
<b>Storage Temperature:</b>	-30°C to +70°C (-22°F to +158°F)
<b>Humidity:</b>	5 to 95 %, non-condensing
<b>Altitude:</b>	The maximum operating altitude is 2000 m (6100 ft.)
<b>Shipping:</b>	Weight: 3.9 kg (8lbs. 10 oz.) Carton: 38 x 25 x 18 cm (15" x 9.8" x 7.1").

**Voltage, Current, Status, Relay and Power inputs all pass the  
ANSI/IEEE C37.90A-1989 surge withstand and fast transient tests.**



LISTED  
INDUSTRIAL CONTROL EQUIPMENT  
1T98



LR 57329  
UL 3111-1  
NRTL/C

## APPENDIX E

### MODEL/ORDERING INFORMATION

#### BASIC MODELS

3720ACM	includes front panel display / keypad
3720ACM TRAN	without display / keypad

#### OPTIONS (SPECIFY WHEN ORDERING)

277	To monitor 277/480 Volts (instead of 120 Volts)
347	To monitor 347/600 Volts (instead of 120 Volts)
1AMP	1 Amp nominal full scale current inputs
XAMPS	200% overrange capability on Amps inputs
YAMPS	500% overrange capability on Amps inputs
ZAMPS	1000% overrange capability on Amps inputs
SSR	SPST solid state relays (instead of Form C dry contact electromechanical)
P24/48	20 to 60 VDC powered (instead of 85 to 264 VAC or 110 to 300 VDC)
XTEMP	Extended operating temp. range: -20°C to +70°C (-4°F to +158°F)
TROP	Tropicalization (conformal coating) treatment
RACK	19 inch rack mountable chassis
MPCC	Multiport communications card
MPE	Multiport communications card with Ethernet

#### ORDERING EXAMPLE

3720ACM -277 -XAMPS -SSR



## APPENDIX F

### WARRANTY AND REGISTRATION

#### WARRANTY

This product is warranted against defects in materials and workmanship for three years. The Warranty is effective from date of purchase. POWER MEASUREMENT LIMITED will repair or replace, at its option, any product found to be defective (F.O.B. point of manufacture) during the Warranty period, provided the equipment has been installed, wired, programmed, and operated in accordance with the manufacturer's instruction manual included with each unit, and the applicable sections of the Electrical Code.

The Warranty will be invalid if any unauthorized alterations are made to the product, or if the product has been abused or mishandled. Damage due to static discharges will void the Warranty, as will application of voltages or currents outside the specified ratings of the device inputs.

EXCEPT TO THE EXTENT PROHIBITED BY APPLICABLE LAW, NO OTHER WARRANTIES, WHETHER EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, SHALL APPLY TO THIS PRODUCT; UNDER NO CIRCUMSTANCES SHALL POWER MEASUREMENT LIMITED BE LIABLE FOR CONSEQUENTIAL DAMAGES SUSTAINED IN CONNECTION WITH SAID PRODUCT AND POWER MEASUREMENT LIMITED NEITHER ASSUMES NOR AUTHORIZES ANY REPRESENTATIVE OR OTHER PERSON TO ASSUME FOR IT ANY OBLIGATION OR LIABILITY OTHER THAN SUCH AS IS EXPRESSLY SET FORTH HEREIN.

#### PRODUCT RETURN PROCEDURE

The following procedure must be strictly adhered to when returning any POWER MEASUREMENT product to the factory for the purpose of repair, replacement, credit, upgrade, recalibration, or for any other reason.

1. Contact POWER MEASUREMENT or your local POWER MEASUREMENT Sales Representative and obtain a *Return Merchandise Authorization* (RMA) number prior to shipment of any unit back to the manufacturer. Be prepared to provide the product's model number, serial number, and the reason for returning the unit. **Units received without prior authorization will not be accepted under any circumstances.**
2. If the unit is being returned for repair, replacement, or upgrade a *product return report* should be completed and included with the unit. The information provided should include:

A functional description of the unit defect or failure and the electrical/environmental conditions at the time of failure. This will significantly reduce repair/upgrade time (and cost, if warranty has expired). If the unit is being returned for an upgrade, recalibration or other modification, list the requirements.

The RMA number issued by POWER MEASUREMENT, the serial number of the unit, the company name and address, the name of the person filling out the report, and the date.

**IMPORTANT: The return address to which the unit is to be shipped following servicing.**

3. Pack the unit safely, preferably in the original shipping carton, and include the detailed report described above. **The RMA number must be clearly marked on the outside of the box.**
4. A packing slip must be attached to the outside of the box which includes the points of origin and destination, a description of contents, and the reason for return. Examples: *For Repair and Return*, or *Returned for Credit*. There should be no need to declare a value.
5. Ship PREPAID to the appropriate address below. POWER MEASUREMENT will not accept C.O.D. shipments. If the unit is still under warranty, POWER MEASUREMENT will pay the return shipping charges.

#### *For shipments originating in the U.S.A.:*

Power Measurement Ltd.  
c/o VICTORIA CUSTOMS BROKERS  
4131A Mitchell Way  
Bellingham, WA 98226

#### *For shipments originating overseas:*

Power Measurement Ltd.  
2195 Keating Cross Road  
Saanichton, BC V8M 2A5  
  
CUSTOMS CLEARANCE  
Livingston International Inc.  
Telephone: (250) 388-4435

#### *For shipments originating in Canada:*

Power Measurement Ltd.  
2195 Keating Cross Road  
Saanichton, BC V8M 2A5

#### REGISTRATION

Please complete and mail the enclosed *Warranty Registration* card immediately. This will allow us to add you to our mailing list, to keep you up to date on the latest product firmware releases and new feature offerings.

Your comments and suggestions for product improvement and feature additions are welcome.





## APPENDIX G

### TROUBLESHOOTING

A number of problems can cause the 3720 ACM not to function properly. This chapter lists a number of symptoms, and explains how to correct them.

1. If the display does not operate:
  - a) check that there is at least 110 volts available to the power supply (L and N connections on the terminal strip).
  - b) confirm that the Chassis Ground Lug terminal is connected directly to ground.
  - c) turn the power off for 10 seconds.

If the above steps do not solve the problem, perform the following:

- a) As a diagnostic test, turn the unit off (disconnect power) for at least ten seconds. Apply power again and check if the unit powers up correctly.
  - b) Contact POWER MEASUREMENT or your local POWER MEASUREMENT representative and report the problem and results of the test.
2. If the voltage or current readings are incorrect:
    - a) check that the voltage mode is properly set for the given wiring.
    - b) check that the voltage and current scales are properly set.
    - c) make sure the Chassis Ground Lug terminal is properly grounded.
    - d) check the quality of the CT's and PT's being used.
    - e) make the following voltage tests:
      - i) V1, V2, V3 to VREF should be 120 VAC (for the standard voltage input option). This depends on the voltage input option installed (i.e. -277, -347).
      - ii) Chassis Ground Lug to switchgear earth ground should be 0 V.

3. If the kW or Power Factor readings are incorrect but voltage and current readings are correct:

Make sure that the phase relationship between voltage and current inputs is correct by comparing the wiring with the appropriate wiring diagram. Note that POWER MEASUREMENT's M-SCADA PC-based software can be used to verify PT and CT sequence and polarity by analyzing the captured voltage and current waveforms for each phase.

4. If RS-232C or RS-485 communication does not work:
  - a) check that the baud rate of the host computer/PLC is the same as that of the 3720 ACM.
  - b) check that the communications mode (RS-232 or RS-485) set by the jumper on the communications card is correct for the type of standard being used (see Chapter 2, Section 2.6.2).
  - c) check all communications wiring (see Chapter 2, Figures 2.6.4 to 2.6.6).
  - d) check that the number of data bits is set to 8, with one stop bit and no parity.

If the above steps do not solve the problem, perform the following:

- a) As a diagnostic test, turn both the 3720 ACM off (disconnect power) and the computer off for at least ten seconds. Apply power again and check if the communications operate successfully.
- b) Contact POWER MEASUREMENT or your local POWER MEASUREMENT representative and report the problem and results of the test.

If the symptom persists after performing the specified steps, or if the symptom is not listed above, contact your local POWER MEASUREMENT representative or the technical support / customer service department of POWER MEASUREMENT (see the front of this manual).

